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THESIS

IMPROVING STRATEGIES TO PREVENT AND PREPARE FOR RADIOLOGICAL ATTACK

by

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March 2010

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13. ABSTRACT (maximum 200 words)

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This thesis surveys the prevalence of radiological material in society, as well as major U.S. programs to secure international trade, U.S. borders, and radiological material, and to prepare the public in order to determine their effectiveness against the threat of radiological attack.

The research conducted indicates that U.S. government strategies against the radiological threat favor costly and problematic technological detection programs over public preparedness strategies, which are not optimized or resourced to address the general public's fear of radiation, fatalism toward terrorism preparedness, and skepticism of the government as a credible source of information on terrorism and radiation.

This thesis concludes that the government should empower the Weapons of Mass Destruction czar with strategic oversight and technology funding-approval authority to de-conflict and streamline technological detection programs at the national level. It should also improve public education outreach resourcing and capabilities to increase public preparedness, thereby developing the public into a national security asset.

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IMPROVING STRATEGIES TO PREVENT AND PREPARE FOR RADIOLOGICAL ATTACK

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LIST OF ACRONYMS AND ABBREVIATIONS

ASP	Advanced Spectroscopic Portal
CBP	U.S. Customs and Border Protection
CDC	Centers for Disease Control and Prevention
CERT	Community Emergency Response Team
CSI	Container Security Initiative
C-TPAT	Customs-Trade Partnership Against Terrorism
DOD	U.S. Department of Defense
DOE	U.S. Department of Energy
DHS	U.S. Department of Homeland Security
DOS	U.S. Department of State
DNDO	Domestic Nuclear Detection Office
EPA	Environmental Protection Agency
EMI	Emergency Management Institute (FEMA)
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FSU	Former Soviet Union
FY	Fiscal Year
GAO	Government Accountability Office
GTCC	Greater Than Class C
HEU	Highly Enriched Uranium
HHS	Department of Health and Human Services
HSGP	Homeland Security Grant Program
HSPD	Homeland Security Presidential Directive
IAEA	International Atomic Energy Agency
IND	Improvised Nuclear Devices
ITDB	Illicit Trafficking Database
LANL	Los Alamos National Laboratory
LVS	License Verification System
MRC	Medical Reserve Corps
NAS	National Academy of Sciences
NRC	Nuclear Regulatory Commission
NNSA	National Nuclear Security Agency

NORM	Normally Occurring Radioactive Material
NPM	National Preparedness Month
NSPD	National Security Presidential Directive
NSTS	National Source Tracking System
OSRP	Off-Site Recovery Program
PAG	Protective Action Guides
PNNL	Pacific Northwest National Laboratory
POE	Port of Entry
POV	Personally Owned Vehicle
PVT	Polyvinyl Toluene
RIID	Radiation Isotope Identification Device
RDD	Radiological Dispersal Device
RPM	Radiation Portal Monitor
RTG	Radioisotope Thermal-electric Generator
SAFE	Standard to Secure and Facilitate Global Trade
SAFE (Port Act)	Security and Accountability for Every Port
SFI	Secure Freight Initiative
SLD	Second Line of Defense
SRNL	Savannah River National Laboratory
TSA	Transportation Security Administration
USCG	United States Coast Guard
VIPS	Volunteers in Police Service
WBL	Web-Based Licensing
WCO	World Customs Organization
WMD	Weapons of Mass Destruction

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I. INTRODUCTION

A. BACKGROUND

A radiological attack fortunately has not been executed to date, yet three analogous cases serve as cautionary tales of the hazards posed by radioactive source material. The first is the accidental leak of radioactive cesium-137 and subsequent contamination in Goiânia, Brazil, in 1987, by illegal scrap metal harvesters, who disassembled a cancer therapy machine. This case serves as an indicator of how devastating the contamination and socioeconomic damage from a malicious radiological dispersal event could be.[1] The second case is the 1995 planting of several kilograms of radioactive cesium in a Moscow park by Chechen separatists, and subsequent recovery by Russian authorities. This case demonstrates that possession and use of radiological material by non-state actors is a credible threat.[2] The third case is the 2001 injury of two Georgian woodcutters who were severely burned from a Soviet-era Strontium-90 Radioisotope Thermal-electric Generator (RTG), which they huddled around for warmth, highlighting the existence of orphaned and disused sources of significant radioactivity that could be exploited for malicious purposes.[3]

B. RESEARCH QUESTION

Are the detection, denial and public preparedness strategies employed by the U.S. government to combat the threat of radiological attack capable of preventing attack and minimizing the effects of an attack?

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[1] Peter D. Zimmerman and Cheryl Loeb, "Dirty Bombs, the Threat Revisited," *Defense Horizons*, no. 38, (2004), http://www.hps.org/documents/RDD_report.pdf (accessed 7 September 2009).

[2] Michael Specter, "Chechen Insurgents Take Their Struggle To a Moscow Park" *The New York Times*, November 24, 1995, at http://www.nytimes.com/1995/11/24/world/chechen-insurgents-take-their-struggle-to-a-moscow-park.html (accessed 26 August 2009).

[3] "Radiothermal Generators Containing Strontium-90 Discovered in Liya, Georgia" Nuclear Threat Initiative, at http://www.nti.org/h_learnmore/radtutorial/3_moscow.html (accessed 2 September 2009).

C. RESEARCH OBJECTIVE AND SCOPE

This thesis seeks to investigate various radiological material detection and denial and public preparedness programs in order to determine their capability to prevent a radiological attack, or prevent such an attack from having a maximal impact on society. This thesis will survey non-DoD programs designed to prevent a domestic radiological attack. While focusing on domestic protection and preparedness programs, this thesis recognizes that some programs, such as trade and border security, involve operations overseas, and have been included. This thesis is not intended to be all-encompassing of domestic protection and preparedness programs, but focuses on several major programs that are vital to radiological protection and preparedness.

D. LITERATURE REVIEW

Although radiological weapons are Weapons of Mass Destruction (WMD) under United States law,[4] they are not treated as such in academic and government literature consistently. The Radiological Dispersal Device (RDD) threat is frequently differentiated from other WMD regarding the potential for mass casualties.[5] This bias has resulted in administratively downgrading the RDD threat in scholarly writing. In the comprehensive book on the WMD threat, *America's Achilles Heel: Nuclear Biological and Chemical Terrorism and Covert Attack*, Richard Falkenrath excludes RDDs as a credible threat, citing RDD "low lethality,"[6] and additionally, that "large quantities of highly radioactive material would generally be needed to produce strong [dose] effects over even a moderate area."[7] Yet, he cites the main threat of RDDs as one of panic and social disruption effects beyond the capabilities of the RDD itself, due to a

[4] 18 U.S. Code, Sec 2332a. "Use of Weapons of Mass Destruction," http://uscode.house.gov/uscode-cgi/fastweb.exe?getdoc+uscview+t17t20+1085+3++%28%20%20%281 (accessed 22 August 2009).

[5] Richard A. Falkenrath, *America's Achilles Heel: Nuclear Biological and Chemical Terrorism and Covert Attack* (Cambridge, MA: MIT Press, 2001).

[6] Ibid., 15.

[7] Ibid.

“widespread public fear of radiation”[8] resulting in medical infrastructure overloading caused by the uninjured “worried well,” as seen after the 2003 World Trade Center bombing.[9] The outright economic damage through destruction, contamination, public fear, and the temporary or permanent loss of an area to radiological contamination could cost billions.[10]

Recent and prominent government reports on the WMD threat share the differential treatment of RDDs as Weapons of Mass Disruption. *World at Risk: The Report of the Commission on the Prevention of WMD Proliferation and Terrorism*, is silent on the RDD threat specifically, despite the mandate to study chemical, biological radiological, and nuclear threats. The commission instead elected to “focus solely on the two types of WMD categories that have the greatest potential to kill in the most massive numbers: biological and nuclear weapons.”[11]

An in-depth quantification of RDD isotopes can be found in reporting from Los Alamos National Laboratory (LANL) on large industrial source applications and proposed alternative technologies.[12] The reports propose that of the millions of radioactive sources worldwide, the subset of large industrial sources contain the amounts of radioactive material that terrorists might seek. The industrial applications representing the greatest radiological terrorism threat include industrial irradiators, mobile irradiators, research irradiators, Soviet-era seed irradiators, teletherapy machines, blood irradiators, RTGs, radiography sources,

[8] Falkenrath, *America’s Achilles Heel,* 15.

[9] Ibid., 6.

[10] Ibid., 7.

[11] Bob Graham et al., *World at Risk: The Report of the Commission on the Prevention of WMD Proliferation and Terrorism,* (New York: Vintage Books, 2008), xvi.

[12] Gregory J. Van Tuyle et al., “Reducing RDD Concerns Related to Large Radiological Source Applications,” Los Alamos National Laboratory, Report LA-UR-03-6664, 2003, http://www.nti.org/e_research/official_docs/labs/LAUR03-6%202.pdf (accessed August 24, 2009); Gregory J. Van Tuyle and Evelyn Mullen, “Large Radiological Source Applications: RDD Implications and Proposed Alternative Technologies,” Los Alamos National Laboratory, report LA-UR-03-6281, 2003.

and well-logging sources.[13] These reports provide insights into the chemical form and level of radioactivity of threat isotopes, as well as the design and security afforded to the industrial application housing them, as well as the implications of accessing, concealing, and employing RDD source material.[14]

The United States employs various material detection and denial strategies to combat the radiological terrorism threat domestically. The Domestic Nuclear Detection Office (DNDO), under the Department of Homeland Security (DHS), is charged with the mission to protect the homeland from radiological material smuggling.[15] The DNDO seeks to install radiation detection equipment at most U.S. ports of entry and selected interior borders at a projected cost of $2 billion,[16] as well as secure smuggling pathways between official ports of entry by small maritime craft, general aviation, or overland routes. The NRC is challenged with ensuring that radiological materials do not fall into terrorist hands through manipulation of licensing processes, an area that has proven problematic.[17]

The National Nuclear Security Agency (NNSA) was established by Congress in 2000 as a semiautonomous organization within the Department of Energy (DOE). As part of a comprehensive effort by the United States to combat nuclear and radiological terrorism, the NNSA detects, secures, and disposes of nuclear and radiological material under a variety of circumstances within the United States and abroad.[18]

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[13] Van Tuyle et al., “Reducing RDD Concerns,” 1–5.

[14] Ibid., 28–30.

[15] “National Security Presidential Directives [NSPD] in the George W. Bush Administration,” Federation of American Scientists, http://www.fas.org/irp/offdocs/nspd/index.html (accessed 24 August 2009).

[16] U.S. Government Accountability Office, *Combating Nuclear Smuggling GAO-09-655*, (Washington: D.C. GAO, 2009), 2.

[17] U.S. Government Accountability Office, *Nuclear Security GAO-07-1038T* (Washington, D.C.: GAO, 2007).

[18] NNSA Web site, at http://nnsa.energy.gov/nuclear_nonproliferation/index.htm (accessed 17 September 2009).

FEMA and DHS are pursuing all-hazards public preparedness through multiple programs such as Citizens Corps, the Ready Program, and Community Emergency Response Teams (CERT) that are designed to increase individual and community responsibility and social activism, reducing the impacts of disasters on communities.[19]

Government oversight reporting has been invaluable in chronicling the development of U.S. detection, denial and preparedness strategies. The Government Accountability Office (GAO) illustrates the numerous strategic, organizational, and technical hurdles that the government and its agencies face in developing effective prevention and preparedness programs.[20] Additionally, GAO investigative operations to evaluate border security and RDD source material interdiction efforts have uncovered significant vulnerabilities. GAO investigators, using commercially available software and open source information, established dummy corporations, received and subsequently altered authentic Nuclear Regulatory Commission (NRC) licenses, and used those licenses to fraudulently procure quantities of radiological source materials allegedly suitable for use in an RDD.[21] GAO personnel, posing as contractors, then transported the radioactive materials simultaneously across both the U.S.–Canada and U.S.-Mexico borders using fake transport documents.[22] While Customs and Border Protection (CBP) agents were able to detect the radioactive material, GAO investigators were not interdicted because Customs and Border Patrol personnel could neither recognize false NRC credentials and shipping documents, nor verify the authenticity of the documentation through interagency cooperation with the NRC.[23] Such reporting indicates that technological and

[19] Citizens Corps, "Citizens Corps Councils," Citizens Corps, http://www.citizencorps.gov/councils/ (accessed 9 February 2010); Federal Emergency Management Agency, http://www.ready.gov/ (accessed 13 March 2010);

[20] U.S. Government Accountability Office, *Combating Nuclear Smuggling,* 3.

[21] U.S. Government Accountability Office, *Border Security: GAO-06-583T* (Washington, D.C.: GAO, 2006), 3–4.

[22] Ibid.

[23] U.S. Government Accountability Office, *Border Security: GAO-06-583T,* 3–4.

procedural efforts to detect and deny RDD materials may still be vulnerable to fraud, pointing to the need to investigate the practical and objective limitations of technological threat reduction strategies, and how technological solutions can be augmented through the use of other strategies such as public preparedness to minimize the effects of a radiological attack.

E. SIGNIFICANCE OF RESEARCH

The United States is undertaking massive efforts to prevent radiological terrorism. Such efforts, consisting of denial, detection, and public preparedness strategies, cannot realistically achieve perfect protection of the population or hope to completely mitigate the impacts on society that perpetrators of a radiological attack seek to inflict. These strategies should, however, represent a concerted effort to combat the threat, and complement other U.S. strategic interests, priorities and policies. This thesis will survey the significant relevant programs the government pursues to determine their successes, gaps, and opportunities for improvement. In so doing this thesis seeks to make relevant policy recommendations regarding detection, denial, and public preparedness programs to counter the radiological terrorism threat. By analyzing the radiological threat in this manner, variables such as perpetrator motivation are set aside and the threat is analyzed such that informed decisions can be made about the efficiency and effectiveness of radiological threat reduction measures.

The dispersal of significant amounts of radioactive contamination represents a serious threat to the nation due to the potential for widespread contamination of vital territory, economic loss, and detrimental societal impacts. Only nuclear WMD surpass the ability of an RDD to deny Americans the use of territory for very long periods of time. At issue in a modern, liberal democratic society such as the United States is balancing security while facilitating a free modern society. The implications of the disruptive effects of an RDD attack require the nation to carefully evaluate security against economic and social freedom. Finite resources and the effects of their misallocation make the

appropriateness of U.S. security policy importance critical area of study. The wrong-headed approach to security can easily create more, and more costly, problems than are solved.

The U.S. has reformed and created various government agencies to protect the populace, expending considerable national resources to counter the RDD threat, while attempting to avoid restricting society. It is important, then, that efforts to protect American society from the threat of radiological attack are effective. As John Parachini concludes in the article “Putting WMD Terrorism into Perspective,” “Inordinate attention on the comparatively unique challenges of coping with unconventional weapons draws scare resources away from the more basic but essential activities of law enforcement, intelligence, border and customs control, diplomacy, and military action.”[24]

F. THESIS OVERVIEW

The thesis will be organized in the following manner. Chapter I provides an introduction, literature review, research questions, organization and scope of the thesis.

The second chapter surveys the prevalence of radioactive sources in domestic society, the risk posed by their use in an RDD, the impacts of the radiological accident in Goiânia, Brazil, to illustrate the effects of even a small radiological terrorist attack on society. The second chapter next surveys several major programs the United States pursues towards radiological material detection and denial to protect U.S. borders, global trade, and the domestic interior.

The third chapter surveys the main programs the United States has undertaken in the realm of public education outreach and preparedness, to determine if those efforts attempt to build resilience against the threat and impacts of a radiological attack.

[24] John Parachini, “Putting WMD Terrorism in Perspective.” *The Washington Quarterly* 26, no. 4 (Autumn 2003), 48.

Chapter IV offers conclusions and recommendations regarding the improvement of U.S. detection, denial and public preparedness strategies and programs, and discusses conclusions based on this research.

II. THE PREVALENCE OF RADIOLOGICAL MATERIAL AND DOMESTIC PREVENTION PROGRAMS

The purpose of this chapter is to highlight the extent to which highly radioactive sources are used in society and the potential for terrorist exploitation of these materials in a radiological attack, and to survey the major detection and denial programs in place to determine how well they are able to detect and deny these radioactive materials to terrorists. This chapter will first highlight the radioactive sources of greatest concern to RDD terrorism, and then illustrate the impact of even a small radiological event by surveying the accidental release of radioactive cesium chloride powder in Goiânia, Brazil, in 1987. This chapter will next survey some of the major detection and denial programs the United States is pursuing to combat illicit radiological material acquisition through trade, border, and regulatory security programs.

A. RADIOACTIVE MATERIAL USES IN SOCIETY

In the United States, over two million radioactive sealed sources are licensed for use in thousands of processes that improve the quality of life.[25] Radiological material serves three general purposes: to alter or kill living cells, for standalone power generation, and for the scanning and measurement of materials.[26] Fortunately, the majority of radioactive sources are too small to be used in a credible radiological attack. Various larger industrial applications do contain quantities of radioactive material that would be readily usable in a significant radiological attack, such as a radiological dispersal device (RDD). This section discusses the types and prevalence of these larger industrial radioactive sources that present a risk for RDD use.

[25] U.S. Government Accountability Office, *Nuclear Security,* 1.

[26] Van Tuyle et al., “Reducing RDD Concerns,” 16.

1. Large Industrial Source Applications

Large industrial source applications include nine major types: industrial irradiators, mobile irradiators, research irradiators, seed irradiators, cancer therapy devices, blood irradiators, radioisotope thermal-electric generators (RTGs), radiography sources, and well-logging sources.[27] These large industrial applications are of concern for the amount and type of radioactive materials they contain as well as their potential vulnerability to unauthorized access, theft or recovery of their source material for use in a radiological attack.

a. Industrial Irradiators

Industrial irradiators are fixed facilities, serving functions such as the sterilization of equipment and irradiation of food products to kill microbial pests. Due to the high investment cost of establishing these facilities, they are relatively rare, numbering around 190 facilities worldwide in 2003.[28] Industrial irradiator facilities are typically designed and built by large Western corporations and afforded "significant safety and security features."[29] Yet, industrial irradiators are of concern due to the large amounts of radiological material they contain, typically hundreds of thousands to millions of curies of activity.

Besides the overt security practices in place, these facilities can be to some extent self-protecting due to potentially fatal levels of radiation near the source. These facilities typically utilize hundreds of cobalt-60 source "pencils," or tubes that contain stacks of small cobalt-60 pellets.[30] Cobalt-60 has monetary

[27] Gregory J. Van Tuyle and Evelyn Mullen, "Large Radiological Source Applications: RDD Implications and Proposed Alternative Technologies," Los Alamos National Laboratory, Report LA-UR-03-6281, 2003, 1–5.

[28] T. Strub and Gregory J. Van Tuyle, "Large Radiological Source Production and Utilization and Implications Regarding RDDs," Los Alamos National Laboratory, Report LA-UR-03-5432, July 2003,.18.

[29] Van Tuyle et al., LA-UR-03-6664, September 2003, 19.

[30] Ibid.

value because it can be recycled in a reactor and reused, reducing the risk that cobalt-60 sources will become disused or abandoned.[31]

b. Mobile Irradiators

Mobile Irradiators are irradiators that are built onto modified trucks and are designed to accommodate various goods. Mobile irradiators typically contain on the order of tens of thousands of curies of gamma-producing radioactive material, such as cesium chloride. Their mobility, use of readily dispersible cesium chloride, and a lack of information regarding the number and location of these devices makes them an item of concern.[32]

c. Research Irradiators

Research irradiators are scaled-down versions of their industrial counterparts, and are frequently produced by the same companies**.** These devices are often used for dosimeter calibration, materials research, sterilization, biomedical research, and entomology research.[33] Research irradiators contain on the order of thousands to tens of thousands of curies of radioactivity in the form of cobalt-60 or cesium-137. These irradiators pose risks due to their smaller size, significant radioactive material sources, and concerns over the level of security that research centers and laboratory facilities may provide.[34]

d. Seed Irradiators

Seed irradiators were developed and deployed in the Former Soviet Union for use in agriculture in the 1970s. Under the Gamma Kolos (Gamma Corn) program, truck-mounted systems containing approximately 3,500 curies of radioactive cesium-137 were used to irradiate corn and grains in order to study the effects on germination rates, induce or prevent germination, and conduct

[31] Van Tuyle et al., LA-UR-03-6281, 2003, 1–5.

[32] Ibid.

[33] Ibid.

[34] Ibid.

research on the potential for creating beneficial mutations.[35] The total number and location of these systems is unknown, but numbers are estimated at between 100 and 1,000 units.[36]

e. Cancer Therapy Devices

Radiation therapy devices focus radiation onto cancerous tissues in the body. The cesium sources originally used in teletherapy machines in the United States were gradually replaced with cobalt-60 and linear accelerator technologies.[37] The latest Gamma Knife systems, however, typically contain between 3,000–15,000 curies of cobalt-60, in as many as 200 separate sources.[38] According to the IAEA's Directory of International Radiotherapy Centers (DIRAC), there are approximately 2,749 teletherapy centers in the United States.[39] Teletherapy devices, like research irradiators, represent a risk due to potential facility security vulnerabilities, as well as for their potential to be fraudulently acquired.[40]

f. Blood Irradiators

Blood irradiators are filing-cabinet sized machines used to sterilize bagged blood in order to prevent Graft-Versus-Host Disease in bone marrow acceptor patients and patients who are immunocompromised.[41] These devices contain a cesium-137 source of between 600 and 5,000 curies of radioactivity. The source capsules in these devices are welded into the frame of the machine,

[35] Van Tuyle et al., LA-UR-03-6281, 2003, 1–5.

[36] Richard Stone, "The Hunt for Hot Stuff," *Smithsonian*, (March 2003), 58–65; Van Tuyle et al., 2003, 1–5.

[37] Van Tuyle et al., LA-UR-03-6664, September 2003, 22.

[38] Ibid.

[39] International Atomic Energy Agency, "Directory of Radiographic Centers," International Atomic Energy Agency, http://www-naweb.iaea.org/nahu/dirac/login.asp (accessed 17 December 2009).

[40] Van Tuyle et al., LA-UR-03-6281, 2003, 3.

[41] Van Tuyle et al., LA-UR-03-6664, September 2003, 23.

necessitating transport in their entirety for service and source replacement.[42] As with other medical sources, the site security afforded these devices, their portability, and the use of readily dispersible cesium chloride powder make blood irradiators worthy of concern.

g. Radioisotope Thermal-Electric Generators (RTGs)

Radioisotope Thermal-electric Generators are portable power supplies that rely on radioactive decay to produce heat, which is converted into electricity. Terrestrially, RTG deployment to remote areas poses significant risk of terrorist exploitation. RTGs can contain up to several hundred thousand curies of radioactive material, typically strontium-90, which is highly dispersible.[43]

The United States and the former Soviet Union (FSU) have both deployed RTGs. The FSU used large RTGs containing strontium-90 as lighthouses from the 1960s through the 1990s along remote northern coastal areas.[44] There have been numerous instances of vandalism of Soviet RTGs, typically by scrap metal harvesters, prompting concerns that terrorists might harvest the radioactive material from one.[45]

The United States deployed RTGs in a variety of applications both inside and outside the United States. The U.S. Air Force maintained ten RTGs in Alaska as part of a seismic sensor array on Burnt Mountain,[46] while the Navy deployed numerous RTG configurations to provide power in remote locations for navigation beacons, communications relays, remote weather stations, seismic

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[42] Van Tuyle et al., LA-UR-03-6664, September 2003, 23.

[43] Ibid.

[44] Ibid., 24–25.

[45] Joby Warrick. "Makings of a 'Dirty Bomb: Radioactive Devices Left by Soviets Could Attract Terrorists," *The Washington Post*, 18 March 2002, A01.

[46] Department of Energy, "EA considers DOE sites for storage of RTGs" *The SRS Environmental Bulletin*, 12, no. 1, 9 February 2001 http://www.srs.gov/general/pubs/envbul/2001.htm (accessed 3 March 2010).

sensor arrays, and various buoyed and deep ocean sensors.[47] The Navy also made RTGs available for loan to other federal government entities.[48] RTGs supported these missions in the United States, Alaska, remote Pacific islands, the Arctic, Antarctica, and various oceans.[49]

h. Radiography Sources

According to Los Alamos National Laboratory, over 10,000 new radiography sources are sold every year, and loss and theft are not uncommon.[50] These mobile sources are typically used for inspection purposes, such as the inspection of welds at construction sites. Older sources may contain cobalt-60 and cesium-137, and aggregating these sources could create a potent RDD. Most new radiography sources contain isotopes with shorter half-lives, such as iridium-192.[51] This is advantageous because nuclides with shorter half lives do not pose as great a threat of long-term contamination in a radiological attack scenario. Iridium-192, for example, has a half-life of 74 days.[52]

i. Well-Logging Sources

Well-logging sources are typically used by multi-national oil and mining companies for exploration and assessments of subterranean geology, and typically contain a neutron source in the 15–20 curie range, as well as a cesium source with activity in the tens of curies range for conducting geologic density scans.[53] There are thousands of sources in use worldwide. These units

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[47] Naval Nuclear Power Unit," Radioisotope Thermal-electric Generators of the United States Navy," 10, United States Navy, 1 July 1978.

[48] Ibid.

[49] Ibid.,

[50] Van Tuyle et al., LA-UR-03-6664, September 2003, 26.

[51] Ibid.

[52] Ibid.

[53] Ibid.

are highly mobile, typically carried on trucks, and are sometimes shipped between countries, raising concerns of theft during transport and use.[54]

B. RADIOLOGICAL MATERIAL TRAFFICKING

With radioactive material prevalent in modern society, the opportunities and potential for radioactive material smuggling and terrorist use are numerous. Radioactive material is created and shipped worldwide on a daily basis, presenting risks throughout the material life cycle as it is produced, transported, distributed, sold, used, transferred, consolidated, and disposed of.

While the prevalence of radiological material in society points to a potential vulnerability for terrorist use, radiological material smuggling is in fact a global threat. According to the International Atomic Energy Agency's (IAEA) Illicit Trafficking Database (ITDB), there have been 1,562 confirmed incidents of illicit trafficking of nuclear and radiological material reported worldwide by participating nations from 1993 through 2008. Of these incidents, 336 incidents involved illegal possession and related criminal activities. Additionally, 421 incidents involved reported theft or loss, and primarily involved radioactive sources such as cesium-137, americium-241 strontium-90, cobalt-60, and iridium-192. In 65% of reported cases during this time period, lost or stolen materials have not been recovered. From 2004-2008, the unrecovered material rate increased to around 73%. Un-recovered materials consist of IAEA Category 2 and 3 "dangerous" radioactive sources.[55]

C. IMPACTS OF AN RDD EVENT: GOIÂNIA, BRAZIL

The impacts of a domestic RDD attack are worrisome. Aside from the potential death and destruction that an explosively dispersed RDD might cause outright, the radioactive contamination presents a complex, far-reaching, and enduring problem for the targeted society beyond contamination issues. While an

[54] Van Tuyle et al., LA-UR-03-6664, September 2003, 26.

[55] International Atomic Energy Agency, "ITDB Factsheet September 2009," International Atomic Energy Agency, http://www-ns.iaea.org/security/itdb.htm (accessed 5 January 2010).

RDD attack such as a dirty bomb has not yet occurred, the accidental release of radioactive cesium chloride powder in Goiânia, Brazil in 1987 illustrates the destructive potential and long-term effects that the dispersal of even a small quantity of radioactive material can have, and raises questions about the impacts a larger, deliberate release might have on a society.[56]

The IAEA report on the Goiânia accident revealed that the accident in Goiânia began on 13 September 1987, when two scrap metal scavengers removed a teletherapy machine assembly containing 1,375 curies of cesium chloride powder from an abandoned radiotherapy clinic.[57] The men later disassembled the device, puncturing the cesium chloride source capsule. After sale to a junkyard, the powder was discovered and distributed to family members, who applied the powder to their bodies in the manner of Carnival glitter.[58]

Between 21 and 24 September, the wife of the junkyard operator fell ill with acute radiation sickness. Her mother cared for her for two days, and then returned home outside of town, spreading contamination to her own residence. The mother would later be diagnosed as having ingested an estimated 270 microcuries of cesium, giving her a dose of around 430 rads.[59] This dose is near the 500-rad lethal dose for half the population (LD_{50}), yet she survived.[60] The first diagnosis of radiation poisoning was made on 28 September, when the wife of the junkyard operator and one of the junkyard employees put the source capsule in a plastic bag and took it by bus to a clinic where it was shown to a doctor.[61]

[56] International Atomic Energy Agency, *The Radiological Accident in Goiânia*, (Vienna: International Atomic Energy Agency, 1988).

[57] Ibid., 1, 11, 23.

[58] Ibid., 23–24.

[59] Ibid., 24.

[60] Ibid.

[61] Ibid., 24–26.

In all, 112,000 people (10% of the population of Goiânia) were monitored by Brazilian and IAEA response personnel. Of those, 249 were contaminated.[62] Significantly, 129 people suffered both internal and external contamination, having inhaled or ingested radioactive material.[63] Forty-nine individuals required hospitalization; 20 were highly contaminated, 10 required critical care.[64] In all, five people died.[65]

In terms of the environmental impact, contamination was localized to an area of about one square kilometer, in which 85 structures were found to have significant levels of radioactive contamination.[66] Seven homes were condemned and destroyed, while 42 of 159 homes required decontamination.[67] In total, 3,500 cubic meters of contaminated debris (approximately 115 22-ft trailer loads) were generated from the cleanup effort, requiring storage and environmental monitoring.[68]

Goiânia was also affected by social and economic impacts of the event. The association of the accident to the Chernobyl reactor accident in the Soviet Union the year before had a strong psychological impact on the Brazilian population, and many people feared contamination, irradiation and incurable and fatal diseases.[69] Some discrimination towards the inhabitants of Goiânia occurred, and sales of agricultural products, the economic lifeblood of Goias State, fell by a quarter in the year after the accident,[70] and only after five years did sales return to pre-1987 levels.[71]

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[62] International Atomic Energy Agency, *The Radiological Accident in Goiânia*, 2.

[63] Ibid., 36.

[64] Ibid., 134.

[65] Zimmerman, 2004, 4.

[66] IAEA, 3.

[67] Ibid., 4.

[68] Ibid., 5.

[69] Ibid., 115.

[70] Ibid.

[71] Joseph Magill and Jean Galy, *Radiation, Radionuclides, Radiation,* (Springer, Berlin: 2004), 162.

Notably, intense public and political pressure was cited as playing a major role in recovery from the accident. In determining remediation standards, the standard for the decontamination of homes was set at one-tenth of recommended IAEA action levels.[72] It is likely that the scope of mitigation of any future RDD incident will also be heavily politicized, magnifying the effects of the RDD event itself and pointing to the need for an open dialogue on this issue.

In the United States, the Environmental Protection Agency (EPA) has the lead responsibility to provide radiological emergency planning guidance, known as Protective Action Guides (PAGs), to protect the public from radiation exposure.[73] In 2006, DHS also issued PAGs for use in the event of an RDD or improvised nuclear device (IND), with the primary goal of protecting the public by providing the standards necessary to guide the early and intermediate phases of incident response.[74] These PAGs may be used by federal agencies and state governments to develop their own public health guidance and regulations. Ultimately, PAG guidance are recommendations and not legally enforceable or binding.

PAGs do not establish cleanup levels. Cleanup standards would be determined from a post-event evaluation of the contamination, and would depend in part on the uses of the site with consideration for the lifetime exposure that the contamination creates. A site that is used for business purposes for 8 hours per day would not require the same level of decontamination as housing would, where people might receive exposure 24 hours a day.[75] While state and local authorities make the ultimate decisions under most scenarios, public involvement in politically charged decisions regarding acceptable contamination standards and decontamination efforts would play a crucial role in determining the magnitude of the impact of the event on society. PAGs therefore represent an important component of incident response and community education and preparedness.

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[72] International Atomic Energy Agency, *The Radiological Accident in Goiânia*, 4.

[73] Government Accountability Office, *Nuclear Security GAO-08-598,* (Washington, D.C.: GAO, 2008), 40.

[74] Ibid.

[75] U.S. Government Accountability Office, *GAO-08-598*, 2008, 42.

D. U.S. RADIOLOGICAL DETECTION AND DENIAL STRATEGIES

With radiological materials prevalent in society, and radiological accidents such as occurred in Goiânia to illustrate the severe impacts of an RDD event, it is imperative that the detection and denial strategies the United States pursues are effective and sustainable. Radiological detection and denial is a significant undertaking. The United States has 327 official Ports of Entry (POE), consisting of maritime port terminal facilities, official border crossings, and international airports. The United States borders with Canada and Mexico total 12,034 kilometers, and the U.S. coastline is approximately 19,924 kilometers long.[76] According to CBP, a typical day in 2008 involved the processing of over 70,000 cargo containers and over one million passengers and pedestrians across U.S. borders.[77] This section first describes the analysis the major detection and denial programs the United States is pursuing to prevent radiological terrorism. The research will show that despite great progress in several areas, significant technological, administrative, and operational gaps remain that make the prospect of radiological material detection and denial highly problematic.

After 9/11, DHS took a tripartite approach in countering the threat of clandestine radiological attack, by expanding existing programs, developing overarching programs to enhance existing efforts, and conducting research and development on improved radiation portals.[78] DHS expanded radiation detector deployment programs including the Radiation Portal Monitor Program and the fielding of handheld and portable detectors to CBP and the U.S. Coast Guard (USCG). In 2006, the 2006 Security and Accountability For Every Port Act (SAFE Port Act) formally authorized the establishment of the DNDO within DHS, and charged it with developing an enhanced global nuclear detection architecture and

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[76] CIA World Factbook. "United States," https://www.cia.gov/library/publications/the-world-factbook/ (accessed 17 December 2009.

[77] U.S. Customs and Border Protection. "Snapshot: A Summary of CBP Facts and Figures." Customs and Border Protection. Washington, D.C. March 2009.

[78] Dana Shea, *The Global Nuclear Detection Architecture: Issues for Congress*-RL34564, Congressional Research Service, July 7, 2008, CRS-2.

further implementing the domestic portion of it. The SAFE Port Act also established programs and requirements central to countering the threat of nuclear and radiological weapons and material smuggling through U.S. ports.

The primary focus of U.S. efforts towards prevention of an RDD attack or radioactive material smuggling domestically has thus been on protecting the global supply chain through detection of illicit trafficking of radiological material.

The major organizations involved in domestic radiological material detection and denial programs are the Department of Homeland Security (DHS), its component agencies, notably the DNDO and CBP, and the USCG. DHS works closely with the Department of Defense (DOD), Department of State (DOS), DOE, and the NRC in developing the global nuclear detection architecture.[79]

To meet its mandate to develop an enhanced global nuclear detection architecture, the DNDO conducted an assessment of existing U.S. efforts and found approximately 72 federal programs operating worldwide.[80] The DNDO identified the largest potential gaps for RDD/radiological material smuggling as air, land, and sea pathways between official ports of entry.[81] The DNDO's strategy includes reducing existing stocks of nuclear materials, protecting existing materials from theft or diversion, detection and reporting of illegal material movements overseas, and improving domestic capabilities to detect radioactive materials and interdict them.[82]

The DNDO conceived of the defense against the RDD threat as a global nuclear detection architecture, involving a layered, defense-in-depth concept that

[79] Shea, *The Global Nuclear Detection Architecture,* 1.

[80] U.S. Government Accountability Office, *Nuclear Detection GAO-08-999T,* (Washington D.C.: GAO, 2008), 13.

[81] Domestic Nuclear Detection Office, Department of Homeland Security, Congressional Justification FY2009, The DNDO RD&O-8.

[82] Department of Homeland Security, "The DNDO Overview," 2008, www.gwu.edu/~nsarchiv/nukevault/ebb270/20.pdf, slide 5 (accessed 19 November 2009).

is international in scope. The architecture is composed of three layers—exterior, border, and interior—each presenting multiple opportunities for authorities to detect and interdict threat materials.[83]

In developing a layered, defense in-depth strategy that involves numerous stakeholder agencies throughout government, the DNDO utilizes personnel detailed from CBP, TSA, USCG, as well as the Departments of Energy, Defense, Justice, State, and the Nuclear Regulatory Commission to meet its mandate. The DNDO also works in close partnership with the National Laboratories, academia, and private industry for scientific expertise and research support. Through the utilization of personnel detailed from inter- and intra-agency partner organizations, and close coordination with security stakeholders in all levels of government in the architecture development process, the DNDO seeks to determine the nature of the requirements for the global nuclear detection architecture, and serve as the technology development and fielding conduit to those federal, state, and local agencies that will ultimately operate it. To this end the DNDO has created a national test bed for radiation detection technologies at the Nevada Test Site.[84]

Some of the significant global nuclear detection architecture programs within the global nuclear detection architecture aimed at protecting the U.S. homeland include programs operating beyond U.S. borders, including the Container Security Initiative, (CSI), the Secure Freight Initiative (SFI), the Second Line of Defense program (SLD), the Megaports Initiative, and the Customs-Trade Partnership Against Terrorism (C-TPAT). Additionally, architecture programs at the border and within the interior include CBP monitoring of maritime, aviation, and vehicular traffic at and between official ports of entry, as well as programs like the DNDO's Secure the Cities, NRC's materials licensing program to include

[83] U.S. Department of Homeland Security, "DHS' Domestic Nuclear Detection Office Progress in Integrating Detection Capabilities and Response Protocols OIG-08-19," U.S. Department of Homeland Security, Office of Inspector General, http://www.dhs.gov/xoig/assets/mgmtrpts/OIG_08-19_Dec07.pdf (accessed 15 February 2010), 15.

[84] U.S. Government Accountability Office, *Combating Nuclear Smuggling GAO-05-840T* (Washington D.C.: GAO, 2005), 7.

Web-Based Licensing (WBL) and National Source Tracking System (NSTS), and NNSA's Off Site Recovery Program (OSRP).

1. Programs to Secure Global Trade and Prevent Smuggling

a. Container Security Initiative (CSI)

CBP further seeks to identify high-risk seaborne cargo prior to it reaching U.S. borders. Initiated in January 2002, the Container Security Initiative involves the identification and inspection of cargo containers that pose a risk to U.S. security while the containers are still in foreign ports. CBP, in partnership with Immigration and Customs Enforcement, target and prescreen containers and develop investigative leads regarding potential terrorist threats from cargo destined for the United States.

CBP uses automated targeting tools to identify containers that pose a threat of terrorism based on strategic intelligence. Section 203 of the SAFE Port Act directs CBP to collect cargo information from importers and vessel carriers of non-bulk cargo in advance cargo-loading procedures at foreign ports. Shippers and container vessels bound for the United States are required to transmit specific information to CBP 24 hours prior to departure from the foreign port.[85] The data are known collectively as the "10+2 Rule," and formally as the Importer Security Filing (ISF) and refers to 10 data items that importers must submit prior to loading, to include:

- Seller
- Buyer
- Importer of record number/foreign trade zone identification number
- Consignee number(s)
- Manufacturer or supplier
- Ship to party
- Country of origin

[85] SAFE Port Act, Public Law no. 109-347, 109th Congress, 2nd session, (13 October 2006), Sec. 203.

- Commodity
- Harmonized Tariff Schedule number of the United States (HTSUS)
- Container stuffing location
- Consolidator name and address[86]

The "+2" additional data elements must be submitted by vessel carriers and includes ship stowage plans and container status, such as empty or full. Failures to meet the 24-hour advance submission requirement results in barring the cargo from loading.[87]

For prescreening of containers at port of departure, CBP relies on the Automated Targeting System (ATS) to determine the relative risk score of a given shipping container. Mandated by the SAFE Port Act, ATS uses computer algorithms to assess the shipping data to determine the need for further investigation. Additionally, CBP employs large-scale Non-Intrusive Inspection (NII) capabilities such as x-ray and gamma ray machines, as well as passive radiation portal monitors and handheld radiation isotope identifiers.[88]

b. The Secure Freight Initiative (SFI)

The Secure Freight Initiative began as a pilot program mandated by the SAFE Port Act to discern the potential for scanning all U.S.- bound cargo containers in order to prevent terrorist nuclear or radiological attacks and smuggling via the global supply chain. CBP and DOE, in partnership with the State Department announced the SFI in December 2006.[89] The SFI is a voluntary coalition of terminal operators, cargo carriers, and shipping companies

[86] U.S. Customs and Border Protection, " Importer Security Filing and Additional Carrier Requirements," http://www.cbgov/xp/cgov/trade/cargo_security/carriers/security_filing/sfi_carriers_lxml, August 2009 (accessed 11 January 2010).

[87] Michael Chertoff, Secretary, United States Department of Homeland Security, (Statement for the Record Before the United States Senate Committee on Homeland Security and Governmental Affairs), March 1, 2006, 4.

[88] U.S. Customs and Border Protection, "CSI In-Brief," http://www.cbgov/xp/cgov/trade/cargo_security/csi/csi_in_brief.xml, March 20, 2008 (accessed 17 December 2009).

[89] Department of Homeland Security. "Secure Freight Initiative: Vision and Operations Overview," Department of Homeland Security, http://www.dhs.gov/xnews/releases/pr_1165943729650. shtm (accessed 17 December 2009).

that agree to develop operations that facilitate greater security efforts. The vision of the SFI program is to create an integrated, global detection and information network that shares real-time container x-ray and radiation detection data with countries engaged in maritime trade.[90] The SFI pilot program is reciprocal, allowing foreign countries to request the United States to scan 100% of cargo bound for their ports.[91]

The SFI builds upon both CSI and DOE's Megaports Initiative by integrating the data from these two programs.[92] Under the SFI, container screening combines x-ray imaging with radiation monitoring. DHS provides non-intrusive imaging systems to host governments, while DOE deploys radiation portal monitors, optical character recognition systems, and the communications systems necessary to integrate and pass the data from the systems to the host government and U.S. officials.[93] Radiation alarms or suspicious x-ray data are immediately reported to the host port's government for local resolution. U.S.-bound container data is provided to U.S. Customs officials at the foreign port and is also sent back to the CBP's National Targeting Center in Virginia. There, the data is incorporated into other risk assessment systems to determine the need for further investigation.[94] While SFI was established at seven foreign ports located in Pakistan, Honduras, the United Kingdom, Oman, Singapore, South Korea, and Hong Kong, operations have culminated at the ports of Hong Kong and the Southampton, United Kingdom.[95]

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[90] Department of Homeland Security. "Secure Freight Initiative."

[91] U.S. Government Accountability Office, *Supply Chain Security GAO-10-12*, (Washington, D.C.: GAO, 2009), 5, 9.

[92] Department of Homeland Security, "Secure Freight Initiative," 1.

[93] U.S. House. Subcommittee on Oversight and Investigations of the Committee on Energy and Commerce, Nuclear Terrorism Prevention: Status Report on the Federal Government's Assessment of New Radiation Detection Monitors, 18 September 2007, text in: LexisNexis® Congressional Hearings Digital Collection (accessed 17 December 2009), 36.

[94] Ibid.

[95] Ibid.

According to the GAO, The SFI program has met with limited technical success, is hampered by problems regarding funding, logistics, and international cooperation, and threatens global cooperative customs frameworks that have resulted in the feasibility of 100% scanning of U.S.-bound cargo remaining unproven.[96]

Under SFI, scanning rates from 54-86% were achieved at low-volume ports responsible for less than 3% of U.S. container shipments, and no participating port achieved 100% scanning of U.S.-bound cargo.[97] Larger SFI ports, with a majority of their container cargo bound for the United States, did not achieve scanning rates above 5%.[98] SFI ports encountered challenges related to worker safety concerns, scanning of intermodal cargo, equipment breakdowns, and poor quality images of scanned cargo, prompting concerns among CBP officials are concerned that they and the participating ports cannot overcome the numerous problems faced.[99]

Problems regarding participation, funding, and international cooperation have surfaced as well. Scanning at the port of Busan, South Korea, was allowed at only one of eight terminals, while the ports of Hong Kong and Southampton ceased participation when their support agreements with CBP expired.[100] Customs officials in the United Kingdom withdrew personnel allocated to the program when the 6-month agreement it had with CBP expired, citing personnel costs that prevented the fulfillment of counter-drug and other domestic responsibilities.[101] As a result, SFI at Southampton is a unilateral endeavor, wholly supported by CBP officers and the terminal operator.[102] Hong Kong port officials cited that CBP's statistics showed no trade facilitation benefits for

[96] U.S. Government Accountability Office, GAO-10-12, 2009, 6.

[97] Ibid.

[98] Ibid.

[99] Ibid.

[100] Ibid., 6, 23.

[101] Ibid., 22.

[102] Ibid.

container scanning operations, and that they saw no incentive to SFI participation in terms of their own port security.[103] Further, officials were concerned that equipment and infrastructure costs and impacts on efficiency would make full implementation at all terminals unworkable.[104]

In 2007, the 9/11 Act mandated the screening of all U.S.-bound cargo containers by July 2012 before SFI feasibility was established, and without identifying funding responsibility.[105] GAO points out that no agency has performed a cost estimate to implement the program, while CBP and DOE have spent about $100 million to equip six SFI ports through June 2009.[106] DHS officials told GAO they anticipate continued U.S. funding for the majority of program implementation costs.[107]

GAO also notes that full SFI implementation departs from customs practices that are both globally accepted and risk-based.[108] The World Customs Organization (WCO) Standards to Secure and Facilitate Global Trade (SAFE) Framework, was itself created by CBP and 11 member states of the High Level Strategic Group, and is based on U.S.-conceived incentives like reduced inspections for shippers practicing supply chain security.[109] In effect, the U.S. is unilaterally changing the rules to a “scan everything” policy. In 2008, the European Parliament and WCO member nations advocated repealing the 100% scanning requirement, believing it harmful to world trade.[110] Also, although the

[103] U.S. Government Accountability Office, GAO-10-12, 2009, 23

[104] Ibid.

[105] Ibid., 33.

[106] Ibid., 8.

[107] Ibid., 33.

[108] Ibid., 43.

[109] Ibid., 15.

[110] Ibid., 3–4.

9/11 Act does not mention reciprocity, CBP notes foreign nation intentions to seek U.S. reciprocity, something CBP does not have the manpower to support.[111]

Recognizing the problems of full implementation, DHS and CBP plan to use the “10 +2” rule and a “strategic trade corridor strategy” to scan 100% of U.S.-bound containers at foreign ports where CBP determines the greatest WMD smuggling risks.[112] In the interim, DHS has decided to extend the implementation deadline given the potential trade impacts.[113]

c. The Second Line of Defense Program (SLD)

The Second Line of Defense program is a DOE/National Nuclear Security Agency (NNSA) effort to improve foreign government capabilities to detect and deter nuclear and radioactive smuggling in maritime shipping and across international borders, primarily in the former Soviet Union. NNSA works with foreign governments to provide border crossings, airports, and seaports with radiation detection equipment, training, and initial sustainment support until the host government can assume operational responsibility.[114] SLD encompasses two programs: the SLD Core Program, and the Megaports initiative. The Core Program seeks to install radiation detectors at 500 border, airport, and strategic feeder seaports within 32 countries. An agreement with Russia will put detectors in 350 border crossing locations by the end of 2011.[115]

d. The Megaports Initiative

The Megaports Initiative is a DOE/NNSA partnership with foreign countries that also seeks to prevent nuclear or radiological material smuggling via the global trade network. Begun in 2003, the Megaports Initiative seeks to

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[111] U.S. Government Accountability Office, Maritime Security GAO-08-86T, (Washington, D.C.: GAO, 2007), 41–42.

[112] U.S. Government Accountability Office, GAO-10-12, 2009, 6–7.

[113] Ibid., 7.

[114] National Nuclear Security Agency. ”NNSA's Second Line of Defense Program,” http://nnsa.energy.gov/news/2299.htm, September 2009 (accessed 17 December 2009).

[115] Ibid.

install detection equipment at 100 seaports and scan 50% of global maritime container cargo by 2015. Under the program, DOE/NNSA provides foreign countries with radiation detection technologies and training of personnel. In return, NNSA requires the sharing of data regarding detection and seizures of radioactive materials resulting from the use of the equipment.[116]

As of August 2007, installation at eight ports was completed by DOE: Rotterdam, the Netherlands; Piraeus, Greece; Colombo, Sri Lanka; Algeciras, Spain; Singapore; Freeport, Bahamas; Manila, Philippines; and Antwerp, Belgium (Phase I).[117] In 2008, operational testing was ongoing at four additional ports: Antwerp, Belgium (Phase II); Puerto Cortes, Honduras; Qasim, Pakistan; and Laem Chabang, Thailand.[118] Additionally, DOE had signed agreements to begin work and is in various stages of execution at ports in 12 additional countries, including the United Kingdom, United Arab Emirates/Dubai, Oman, Israel, South Korea, China, Egypt, Jamaica, the Dominican Republic, Colombia, Panama, and Mexico, Taiwan and Hong Kong.[119] Several of these ports are also part of the Secure Freight Initiative. DOE is also engaged in negotiations with approximately 20 additional countries in Europe, Asia, the Middle East, and Latin America.[120]

e. Customs-Trade Partnership Against Terrorism (C-TPAT)

The CBP established C-TPAT in 2001. C-TPAT is a voluntary, government-business initiative to build cooperative relationships that strengthen and improve overall international supply chain and U.S. border security. Under C-TPAT, security is achieved through the close cooperation of CBP and global supply chain stakeholders, to include importers, carriers, consolidators, licensed

[116] National Nuclear Security Agency, "Megaports Initiative," National Nuclear Security Agency, http://nnsa.energy.gov/nuclear_nonproliferation/1641.htm, September 2009 (accessed 18 November 2009).

[117] U.S. Government Accountability Office, GAO-08-86T, 2007, 38–39.

[118] Ibid.

[119] Ibid.

[120] Ibid.

customs brokers, and manufacturers, who validate their supply chains and security procedures with CBP. Once validated, these low-risk companies enjoy such benefits as reduced customs inspection rates and expedited cargo release procedures at U.S. ports of entry.[121] From 2003 to 2008, CBP had conducted over 8,000 supply chain validations.[122]

f. Radiation Screening at and Between Official Ports of Entry

Customs and Border Protection seeks to protect U.S. borders while fostering travel and trade. CBP screens cargo and vehicles for radiological material at land ports of entry using stationary radiation portal monitors. Vehicles drive through the portals, which trigger an alarm when radiation is detected. CBP officers then conduct a secondary inspection, using a second portal to confirm the alarm, and handheld radioactive isotope identifiers to determine if the source material is a threat.[123]

In 2007, the DNDO completed Radiation Portal Monitor (RPM) deployment to the Nation's 22 busiest seaports as mandated by the SAFE Port Act, and by the end of 2007, claimed that 98% of all in-bound containerized ship cargo was screened for radiation using 358 RPMs.[124] Concurrently, in-bound container-screening rates for trucks along the northern border using 241 RPMs and along the southern border using 343 RPMs reached 91% and 97% respectively.[125] Personally Owned Vehicle (POV) traffic is also screened at the northern and souther borders, and, in 2007, 81% of northern border POV traffic

[121] National Nuclear Security Agency, "Megaports Initiative," 6.

[122] United States Customs and Border Protection, "CBP Announces C-TPAT 2008 Year in Review," United States Customs and Border Protection, http://www.cbgov/xp/cgov/newsroom/ news_releases/january_2009/01122009.xml, 12 January 2009 (accessed 17 December 2009).

[123] General Accountability Office, GAO-09-655, 2009.

[124] Vayl Oxford, "Safe Port Act: Status of Implementation One Year Later, Opening Statement," House Committee on Homeland Security, 11 October 2007, 3.

[125] Ibid.

was screened, while 92% of POV traffic was screened at the southern border.[126] Additionally, 60 RPMs were deployed to mail and courier processing facilities.[127]

g. Maritime Security Efforts

Container ships are not the only maritime pathway for illicit radionuclide material to enter the United States. Other potential threat pathways include small vessels, which are recognized in the DHS Small Vessel Security Strategy but are not mandated for screening under the SAFE Port Act. Small vessels are defined as any watercraft, regardless of method of propulsion, generally less than 300 gross tons, and used for recreational or commercial purposes, and include those used for recreation, commercial fishing, towing, and un-inspected passenger vessels, or any other small commercial vessels involved in foreign or U.S. voyages.[128] The DNDO's West Coast Maritime Pilot Program is one effort to combat the threat of small vessel nuclear and radiological attacks and smuggling.

The West Coast Maritime pilot program is a three-year, $10 million pilot program begun in 2007 to provide maritime radiation detection capabilities for state and local authorities in Washington's Puget Sound and California's San Diego areas. The program, conducted in close coordination with USCG and CBP, involves radiation detection architecture development that reduces the threat of illegal transportation of radiological weapons or material aboard recreational or small commercial vessels.

The goal of the pilot program is to evaluate the efficacy of the use of radiation detection equipment and operations by local maritime authorities in

[126] Oxford, "Safe Port Act: Status of Implementation One Year Later," 4.

[127] Ibid.

[128] Department of Homeland Security, Small Vessel Security Strategy, April 2008, 2.

order to develop techniques that can be used in securing other high-risk ports.[129] Under the pilot program, the DNDO is deploying and testing passive detection sensors, such as human-portable radiation detection equipment, mobile sensors, and fixed-position detectors for use by local maritime authorities to include the U.S. Coast Guard. Operational procedures, training, and exercises that support small vessel radiation detection capabilities are also in development.[130] In 2008, the DNDO and Savannah River National Laboratory (SRNL) conducted a test to characterize radiation detection performance of commercially available boat-mounted radiation detectors in the maritime environment.[131] In September 2009, Pacific Northwest National Laboratory (PNNL) and DNDO, along with law enforcement and first responder personnel from USCG, CBP, FBI, as well as Washington state, county, port and local law enforcement participants, conducted another maritime exercise in Puget Sound to assess hand-held and boat-mounted detector technologies and develop operational protocols.[132] According to the GAO, as of 2009 the DNDO had not established criteria for evaluating pilot program success, nor estimated costs of expanding the program to other facilities if feasible.[133]

h. Intermodal Rail

Intermodal rail detection is also currently under development. Two percent of shipping containers arriving in the United States are intermodal rail

[129] Department of Homeland Security, "DHS Announces West Coast Maritime Radiation Detection Project," Department of Homeland Security, http://www.dhs.gov/xnews/releases/pr_1189012515699.shtm, 5 September 2007 (accessed 11 Jan 2009); see also Geoffrey Harvey, "High-tech Nuke Detectors Check Puget Sound Small Vessels for WMD," Pacific Northwest National Laboratory Web site, http://www.pnl.gov/news/release.aspx?id=405, 24 September 2009 (accessed 22 January 2010).

[130] Department of Homeland Security, "West Coast Maritime Radiation Detection Project," 2007.

[131] Savannah River National Laboratory, "SRS Test Program Honored By Department Of Homeland Security," November 20, 2008, srnl.doe.gov/newsroom/2008news/crawdad.pdf (accessed 11 January 2009).

[132] Harvey, "High-tech Nuke Detectors."

[133] U.S. General Accountability Office, *Nuclear Detection GAO-09-257*, (Washington, D.C.: U.S. General Accountability Office, 2009), 5.

containers, or those that are offloaded from ships onto railcars for further transport. These containers exit port facilities without passing through the radiation detectors used to screen tractor trailers. To address this gap, the SAFE Port Act mandated that the DNDO establish an intermodal rail test center.[134] The DNDO selected the port of Tacoma, Washington, in 2007 as the site for the test center because 70% of inbound ship containers are bound for intermodal rail.[135] Projects at the intermodal rail test center include scanning cargo at the dockside, during transport to the rail yard, entering the rail yard, in the container storage stack, during train assembly, and upon train departure from the port.[136]

i. General Aviation Security

In 2009, around 2,000 international commercial flights and another 400 international general aviation flights arrived daily in the United States.[137] With more than 19,000 general aviation facilities operating within the United States, at urban, rural, and remote airports nationwide,[138] general aviation presents a significant threat pathway for the smuggling of radioactive material or RDDs. In April 2007, DHS Secretary Chertoff tasked the DNDO and CBP with conducting radiation screening of all general aviation aircraft arriving in the United States from international locations, which DHS achieved by the end of 2007.[139] CBP hopes to have cargo screening technologies in place at the 30 airports that receive 99% of inbound aviation cargo by 2014.[140]

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[134] The Energy Policy Act of 2005, Public Law 109-58, 109th Cong, 1st session, 8 August 2005; The SAFE Port Act, 109th Cong, 2nd session, 3 October 2006, Sec. 121 (i).

[135] Department of Homeland Security, "DHS Establishes Rail Test Center for Radiation Detection," www.dhs.gov/xnews/releases/pr_1178919294310.shtm, 11 May 2007 (accessed 12 January 2010).

[136] Ibid.

[137] U.S. General Accountability Office, GAO-09-257, 2009, 2.

[138] House, Statement of John Sammon, Assistant Administrator, Transportation Sector Network Management, Before the Subcommittee on Transportation Security and Infrastructure Protection, Committee on Homeland Security, http://homeland.house.gov/SiteDocuments/20090930142059-74081.pdf, 15 July 2009 (accessed 14 January 2010).

[139] The Government Accountability Office, GAO-09-257, 2009, 5.

[140] Ibid., 17.

In December 2008, the DNDO's systems engineering and evaluation directorate initiated a pilot program named the Passenger and Baggage Pilot Program, or PaxBag. The pilot program goal is to address the scanning of commercial airline passengers and baggage traveling through U.S. international airports to determine if they are carrying any illegal radiological or nuclear materials. The PaxBag pilot program seeks solutions for the detection of sources of gamma or neutron radiation emissions at or near real-time, as well as the detection of low-activity radiological materials that may be masked, or shielded by a variety of materials.[141]

E. MATERIALS LICENSING, TRACKING, AND RECOVERY

In addition to radionuclide detection strategies, procedures for licensing, inspecting, and regulating radiological material and those with access to it is a critical piece of radionuclide detection and denial strategies. Even perfect technological detection measures will fail if potential terrorists are able to defeat, circumvent, or manipulate regulatory measures in order to fraudulently acquire radiological materials for malevolent purposes.

1. NRC Material Denial Efforts

The NRC regulates the security and accountability of nuclear and radiological materials in the United States. Under the Atomic Energy Act of 1954, section 274, the NRC may relinquish to the states portions of its regulatory authority to license and regulate byproduct materials (radioisotopes); source materials (uranium and thorium); and certain quantities of special nuclear materials. According to the GAO in 2007, there were 22,000 radiological material license holders in the United States.[142]

[141] Jacob Goodwin, 'PaxBag' Program to Search for Nuke Material on Airline Passengers or in Baggage," Government Security News, http://www.gsnmagazine.com/cms/market-segments/system-integration/1253.html, 15 December 2008 (accessed 15 January 2010).

[142] U.S. Government Accountability Office, Nuclear Security GAO-07-1038T, (Washington, D.C.: GAO, 2007), 1.

Prior to 9/11, the NRC's mission focus was primarily one of safety, in preventing nuclear and radiological materials from harming people. The attacks on 9/11 hastened the broadening of the NRC's mission focus, highlighting the need for improved material security. In 2005, the Energy Policy Act (EPAct) amended the Atomic Energy Act of 1954, and added important changes to improve radionuclide security.

The EPAct established the Radiation Source Protection and Security Task Force chaired by the NRC. The task force is a consultative body comprised of representatives from DHS, DOD, DOT, DOJ, DOS, DNI, CIA, FEMA, FBI, HHS and the EPA. Additionally, the Organization of Agreement States serves as a non-voting member of the task force.[143] The purpose of the task force is to work with stakeholder agencies at all levels of government to recommend legislative and regulatory measures concerning radiation source security to the U.S. government.

The EPAct requires the task force to issue its recommendations in a report to Congress and the President every four years, concerning the areas of threat radionuclides, storage and transportation security, loss and transfer reporting, national tracking, import and export, disposal, alternative technology development, inspections and penalties, and personnel and site security. Once received, by Congress, the NRC then has 60 days to initiate policy changes as the Commission deems appropriate, and to ensure timely compliance by the Agreement States.[144]

Other important provisions of the EPAct included creation of a national source-tracking system, establishment of time limits for licensee reporting of transfer, loss, or theft of a radioactive source, and the amendment of section 149 of the Atomic Energy Act to authorize NRC to conduct fingerprinting and criminal background checks of persons with access to high-risk levels of nuclear and

[143] The Energy Policy Act of 2005, Public Law 109-58, 109th Cong, 1st session, 8 August 2005.

[144] Ibid., Section 651.

radiological materials. The EPAct also mandated that the National Academy of Sciences (NAS) conduct a study of radionuclide uses to determine the potential uses for which radionuclides might be replaced with nonradioactive technologies or substituted with radionuclides that present less of a risk to public health and security.[145]

Significantly, key investigations into NRC licensing procedures by the GAO in 2005 and 2007 have demonstrated the persistence of critical vulnerabilities in the material licensing process despite increased security practices after 9/11, illustrating the potential for terrorist exploitation of regulatory systems to obtain radiological materials.

In 2005, GAO investigators used commercially available software and open source information to establish dummy corporations and download and subsequently alter sample NRC material licenses. Investigators then successfully used those licenses to fraudulently procure quantities of radiological sealed sources allegedly suitable to make two RDDs.[146] GAO investigators then posed as U.S. contractors, and transported the radioactive materials simultaneously across both the U.S.-Canada and U.S.-Mexico borders using the fake NRC documents and bills of lading.[147]

[145] The Energy Policy Act of 2005, Public Law 109-58, 109th Cong, 1st session, 8 August 2005. The NAS study made five recommendations regarding the disuse and replacement of radioactive source material. First, replacement should commence cautiously to preserve the essential functions that various sources provide. Second, the NRC should develop criteria beyond deterministic health effects for security planning purposes, such as considering radiation source potential for widespread contamination and disruptive impacts in the determination of additional security measures. Third, the U.S. government should eliminate Category 1 and 2 cesium chloride sources in the United States and, if possible, elsewhere through licensing cessation, decommissioning incentives, and export prohibition except for disposal. Fourth, the U.S. government should create incentives for the development and adoption of replacement technologies and reduce the benefits of using higher-risk sources. Fifth, the report recommended that an industry working group of the Society of Petrophysicists and Well Log Analysts should characterize the technical obstacles, requirements for new reference standards, and performance of replacement technologies in order to determine the feasibility of replacing americium-beryllium tools like well-logging devices. The National Research Council, *Radiation Source Use and Replacement: Abbreviated Version,* Committee on Radiation Source Use and Replacement (Washington, D.C.: National Academies Press, 2008), 5–10.

[146] U.S. Government Accountability Office, *Border Security GAO-06-583T*, (Washington, D.C.: GAO, 2006), 4.

[147] Ibid.

While CBP agents were able to detect the radioactive material, the material was not interdicted because CBP could not detect fraudulent possession of the material. CBP personnel could neither recognize false NRC credentials and shipping documents, nor had they the capability to verify the authenticity of the NRC license through interagency cooperation or technical reachback with the NRC.[148]

In 2007, GAO conducted parallel investigations of both NRC and Agreement State licensing procedures. GAO investigators again established dummy corporations and applied for material licenses from both the NRC and an Agreement State.[149] The Agreement State informed the GAO investigators that an on-site inspection would be required prior to license issuance, while the NRC did not mandate an on-site inspection, and issued a license within a month.[150] GAO investigators subsequently altered the license, removing language restricting the amount of sealed sources the (fake) company could possess, in order to demonstrate that potential terrorists could aggregate lesser quantities of threat material from suppliers into quantities that could be used in an RDD. Investigators sent copies of the doctored license and letters of intent to purchase devices and received quotes from two suppliers for the purchase of IAEA Category 3 “Dangerous” quantities of source materials.[151]

Both in response to these investigations, as well as due to existing security measure developments mandated by the EPAct, the NRC has developed additional strategies to reduce the likelihood of illicit radionuclide material acquisition, including the National Source Tracking System (NSTS), Web-based Licensing (WBL), and the License Verification System (LVS). Efforts to reduce access to radionuclides include the NRC’s National Source Tracking System (NSTS), Web-based Licensing (WBL), and the License

[148] U.S. Government Accountability Office, *Border Security GAO-06-583T*, 4.

[149] U.S. Government Accountability Office, GAO-07-1038T, 2007, 2.

[150] Ibid.

[151] Ibid., 3.

Verification System (LVS), and NNSA's Off-site Recovery Program, which provides physical removal of radioactive source material.

2. NRC's National Source Tracking System (NSTS)

The concept of a national source-tracking system resulted from a 2002 joint NRC and DOE working group to identify threat radionuclides and potential methods for increasing their security.[152] A national tracking system requirement was later mandated by the Energy Policy Act of 2005, and the NRC's NSTS became operational in January 2009. The NSTS is a secure web-based database designed to track the life cycle of Category 1 and 2 radioactive sources regulated by the U.S. Nuclear Regulatory Commission (NRC) and the Agreement States from "cradle to grave," from when sources are manufactured or imported, until they are exported, disposed of, or decay to a non-hazardous level.[153] The goal of the NSTS is to improve public health and safety and the common defense by improving the ability of the NRC and Agreement States to conduct inspections and investigations, communicate information to other government agencies, and verify the legitimate ownership and use of radioactive material.[154]

In order to combat the threat that lesser activity sources might be acquired and aggregated into a high-risk level, the NRC issued a proposed rule in April 2008 to expand the NSTS to include not only Category 1 and 2 sources, but also 1/10 of the Category 3 threshold.[155] This action would have resulted in additional licensee reporting to the NSTS applications including fixed industrial measuring devices like thickness gauges, blast furnace gauges, and pipe gauges, as well as well-logging devices, brachytherapy sources in the medium- to low-dose range, and some additional radiography devices. The NRC

[152] The Nuclear Regulatory Commission, "History and Expansion of the National Source Tracking System," The Nuclear Regulatory Commission, http://www.nrc.gov/security/byproduct/nsts/nsts-history.html, 27 July 2009, (accessed 23 January 2010).

[153] Nuclear Regulatory Commission, "NSTS Overview," http://www.nrc.gov/security/byproduct/nsts/overview.html, 9 October 2009 (accessed 10 December 2009).

[154] Ibid.

[155] 73 FR 19749, http://www.gpoaccess.gov/fr/, 11 April 2008 (accessed 22 January 2010).

Commission has not enacted the provision as a final rule due to a split vote by Commission members on the final decision.[156]

3. Web-Based Licensing (WBL) and License Verification System (LVS)

NRC's WBL and LVS are complementary programs to NSTS, and are currently under development. The objective of WBL is to provide licensing data to businesses dealing in radioactive materials. While NSTS will track sealed sources "cradle to grave," WBL will do the same for NRC material licenses, and include information from initial license application, date of issuance, amendment, reporting, and de-licensing of NRC licensees. WBL will also have an interface to support Agreement States licensee data management.[157]

The License Verification System (LVS) will verify domestic licensees, interfacing with WBL and NSTS to detect and preventing illicit material acquisition. LVS will ensure license authenticity, licensee authorization to procure materials by quantity and type, and that licensee inventories are in compliance with authorized possession limits.[158] With WBL and LVS, the threat of using fraudulent licenses to acquire radionuclide material and attempts to bypass authorization limits through simultaneous acquisition from multiple vendors should be greatly reduced.

4. NNSA/DOE Offsite Recovery Program (OSRP)

The OSRP is a U.S. government activity supported by NNSA's Office of Global Threat Reduction and is managed by the Nuclear Nonproliferation Division of Los Alamos National Laboratory. The OSRP mission is material denial

[156] Nuclear Regulatory Commission, "NRC Commission Split 2-2 on Expansion of National Radioactive Source Tracking System," Nuclear Regulatory Commission, http://www.nrc.gov/ reading-rm/doc-collections/news/ 2009/09-121.html, 1 July 2009 (accessed 17 December 2009).

[157] "FMSE Materials Controls Portfolio - License Verification System (LVS) and Web-Based Licensing System (WBL) Development and Hosting Environment Consolidation for System Portfolio (LVS, WBL, and National Source Tracking System (NSTS))," Federal Business Opportunities Web site, https://www.fbo.gov/index?s=opportunity&mode=form&id=f1fa5e0c81 cdfacb5a72a538c48d4daf &tab=core&_cview=1, 23 June 2009 (accessed 22 January 2010).

[158] Ibid.

through the removal of excess, unwanted, abandoned, or orphan radioactive sealed sources that pose a risk to health, safety, and national security.[159] OSRP was originally established in DOE's Office of Environmental Management in 1999 for the recovery of sealed sources of Greater than Class C (GTCC) low-level radioactive waste. After 9/11, the OSRP mission expanded in consideration of broader public safety and national security concerns. As a result, OSRP transitioned to NNSA in 2003, and includes the recovery of transuranic material as well as beta/gamma emitting sealed sources.[160] NNSA works in close cooperation with the NRC to identify sources for recovery. Through December 23, 2009, OSRP recovered more than 21,323 sources domestically, and 495 sources from foreign locations, preventing their recovery and use in an RDD.[161]

F. INTERIOR DETECTION

1. Securing the Cities Initiative

Unveiled by the DNDO in May 2006, the Secure the Cities Initiative seeks to expand the global nuclear detection architecture to protect major U.S. urban areas. The pilot program was established in New York City and seeks to assess threat pathways into major cities, such that radiation detection assets and procedures can be implemented to combat the threat. In 2010, the Obama administration will provide $18.5 million for radiation monitor installation in bridges, tunnels and regional toll plazas.[162] While New York remains the only city to participate in the program, adoption of H.R. 2611 would amend the Homeland Security Act of 2002 to include expansion of

[159] Los Alamos National Laboratory. "Off-Site Source Recovery Project, OSRP," http://osrlanl.gov/ (accessed 14 January 2010).

[160] Ibid.

[161] Ibid.

[162] Global Security Newswire, "Securing the Cities Initiative to Receive $18.5M," (National Journal Group, 25 January 2010) http://gsn.nti.org/gsn/nw_20100125_4106.php, (accessed 10 March 2010.

program funding in 2010 to introduce the program in two more locations, with costs through 2014 estimated at $206 million.[163]

G. ARCHITECTURE BUDGETS

In 2007, Congress budgeted a total of approximately $2.8 billion to the 74 programs involved in the prevention and detection of nuclear and radiological material smuggling.[164] Approximately $1.1 billion in funding was appropriated for 28 programs focused on internationally-based architecture; $918 million funded 16 programs for detecting and securing radiological or nuclear material inside U.S. borders; $221 million in support of 9 programs concentrating on at-the-border radiological and nuclear detection programs; and $577 million spread across 34 programs involving multiple layers of architecture such as research and development or technical support.[165]

Regarding the portal monitors to be used for screening cargo at U.S. ports of entry, in September 2008 GAO estimated the life cycle costs (deployment and maintenance) of each standard cargo version of the ASP at approximately $822,000. PVT life cycle costs were estimated at $308,000 for the standard cargo portal. Total program costs for the DNDO's latest deployment plan, which relies on both ASPs and PVTs for detection, yet does not deploy radiation portal monitors at all border crossings, is estimated at about $2 billion.[166]

H. ARCHITECTURE TECHNOLOGIES

The global nuclear detection architecture relies on a few core technologies for radiation detection. These technologies consist of larger sensor arrays used in radiation portal monitors for cargo container screening, to smaller, mobile

[163] Congressional Budget Office. "H.R. 2611: A bill to amend the Homeland Security Act of 2002 to authorize the Securing the Cities Initiative of the Department of Homeland Security, and for other purposes," www.cbo.gov/doc.cfm?index=10848, 10 December 2009 (accessed 12 January 2010).

[164] U.S. Government Accountability Office, *Nuclear Detection GAO-08-999T*, (Washington, D.C.: GAO, 2008), 13.

[165] U.S. Government Accountability Office, GAO-09-655, 2009, 2.

[166] U.S. Government Accountability Office, GAO-08-999T, 2008, 13.

systems for vehicle, backpack and handheld detection and radionuclide identification, to pager-sized radiation detectors worn by law enforcement and first responders.

1. Radiation Portal Monitors

Fixed portal monitors consist of two upright columns, forming a portal between which cargo containers pass as they are moved through port facilities. The DNDO has been developing and testing portal monitors utilizing three sensor technologies: polyvinyl toluene (PVT), sodium iodide (NaI), and high-purity germanium. Each technology has benefits and drawbacks to their use.

PVTs make up the bulk of radiation portal monitors, and were widely deployed in the wake of 9/11 due to their relatively low cost and reliable detection capability. As of July 2008, there were over 1,070 RPMs in service at U.S. air, sea, and land ports of entry.[167] PVTs detect gamma radiation emanating from a vehicle or cargo container when it strikes the polyvinyl toluene scintillator material, creating small photo-electric disturbances that are detected by the PVT's electronics, which then trigger an alarm notifying CBP personnel that radiation has been detected.

But, PVTs have drawbacks. PVTs are unable to distinguish between threat sources and benign Normally Occurring Radioactive Material (NORM), such as glazed ceramics, kitty litter, fertilizer, and bananas, which are commonly traded commodities. PVTs therefore have a high nuisance alarm rate, potentially problematizing the efficient flow of the high volumes of cargo that pass through busy seaports and border crossings. CBP manpower is used in the adjudication of nuisance alarms, and a high-volume port experiences hundreds of these nuisance alarms daily.

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[167] The National Research Council, *Evaluating Testing, Costs, and Benefits of Advanced Spectroscopic Portals for Screening Cargo at Ports of Entry*, (Washington, D.C.: National Academies Press, 2009), 11.

For neutron detection, PVTs rely on helium-3 detection technologies. The portals contain plastic tubes filled with helium-3 gas, which is a non-reactive decay product of the tritium gas used to boost the yield of nuclear weapons. Neutrons emitted from the radioactive material pass through the tubes of helium-3 gas, and are absorbed, producing tritium, protium, and energy. The protium in turn reacts with He-3, producing charged particles and energies, which are detected by the sensor electronics, triggering an alarm.[168]

The DNDO is currently in the development and testing phase of more advanced radiation portal monitors for cargo screening: Advanced Spectroscopic Portals (ASPs). ASPs utilize either high-purity germanium or sodium iodide crystals to detect gamma radiation. These materials allow the ASP to measure the discrete energy levels produced, either by looking at the energy peaks of the radiation detected or by analyzing the spectrum or "fingerprint" of energies produced. These data are then compared to an onboard database of spectra for nuclear, radiological, and NORM material. Spectral matches for threat radionuclides results in the ASP triggering an alarm, whereas matches for NORM do not alarm. This gives the ASP the added capability to not only detect radiation but to identify the source radionuclide, potentially reducing the nuisance alarms inherent in PVT detectors.

2. Isotope Identifiers and Radiation Pagers

CBP personnel are also issued hand-held radiation isotope identifiers (RIIDs). USCG personnel have similarly been issued backpack radiation detectors. These detectors are more advanced than PVTs and radiation pagers because they are more sensitive, and like ASPs, have the ability to identify specific isotopes.

CBP began providing its inspectors at U.S. borders and points of entry with small, personally worn radiation detection devices, known as radiation

[168] Massachusetts institute of Technology, "Helium-3 Proportional Counters," http://web.mit.edu/8.13/www/tgm-neutron-detectors.pdf (accessed 15 February 2010).

pagers, in FY 1998. After 9/11, DHS expanded this effort. Radiation pagers share the PVTs non-discriminatory radiation detection properties. According to DOE officials, radiation pagers have a limited range and are not designed to detect weapons-usable nuclear material.[169] Relatively inexpensive, the pagers are nonetheless useful for the passive screening of individuals and passenger vehicles at ports of entry to detect other, more highly radioactive materials.

I. CHALLENGES TO DETECTION AND DENIAL STRATEGY EXECUTION

Much controversy has surrounded the global nuclear detection architecture. The main areas of critique surrounding the architecture are technological limitations, feasibility, and administrative issues.

1. Technological Limitations

Nuclear materials like HEU and plutonium produce low levels of radiation, meaning that they can be shielded or masked by legitimate cargoes that are more radioactive. Shielding involves placing a dense material around the radionuclide so that the radiation it gives off is absorbed before it reaches the detector. Masking involves using a higher-level radioactive material to hide the radiation signature of a lower level source from the detector. Effective shielding and masking of nuclear materials makes it difficult for even sensitive passive detectors like ASPs and PVTs to detect those materials. DNDO officials acknowledge that passive detectors like PVTs and ASPs can only detect certain nuclear materials if they are unshielded or lightly shielded.[170]

Interestingly, nuclides desirable for use in RDDs are comparatively much more highly radioactive than special nuclear material. This characteristic makes them more readily detected by passive radiation detectors. RDD isotopes thus require greater shielding than nuclear materials, making them harder to smuggle.

[169] U.S. Government Accountability Office, GAO-05-840T, 2005, 3.

[170] U.S. Government Accountability Office, GAO-09-655, 2009, 7.

According to Los Alamos National Laboratory, shielding of radionuclides presents additional opportunities for detection of heat and density signatures.[171]

The technological limitations and costs of RPM technology has caused leaders to question the DNDO's pursuit of the more expensive ASP technology. The 2007 Appropriations Act prohibited the obligation of funding to procure ASP systems until the DHS Secretary certified that ASP technology provides a markedly improved level of performance than current radiation portal monitors.[172] This is an important caveat, as the PVT monitors cost about \$340,000–\$455,000 per unit, while ASPs cost around \$822,000 per unit, prompting GAO to report that cost overruns in the ASP monitor program could amount to over \$1 billion, for a total cost of \$3.8 billion to \$4 billion.[173]

2. Resource Constraints

In testimony before the Investigations and Oversight Committee, House Science and Technology Committee, Dr. William Hagan, acting deputy director of the DNDO, stated that the ASP program was put on indefinite hold due to a severe shortage of the helium-3 gas that is used in radiation portal monitors for neutron detection.[174] Helium-3 is a natural decay product of the Tritium gas used to boost the yield of nuclear weapons. The supply of helium-3 has been decreasing since the end of the Cold War and a reduction of U.S. nuclear forces.[175] The helium-3 shortage resulted in the price of helium-3 skyrocketing,

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[171] Van Tuyle, et al., Reducing RDD Concerns Related to Large Radiological Source Applications," Report LA-UR-6664, Los Alamos National Laboratory, September 2003, 23.

[172] Consolidated Appropriations Act, 2008, Pub. L. no. 110-161, 121 Stat. 1844, 2069 (2007); Consolidated Security, Disaster Assistance, and Continuing Appropriations Act, 2009, Pub. L. no. 110-329, 121 Stat. 3574, 3679 (2008).

[173] U.S. Government Accountability Office, *Combating Nuclear Smuggling GAO-08-1108R*, (Washington, D.C.: GAO, 2008), 4.

[174] Testimony of Dr. William Hagan, acting deputy director, Domestic Nuclear Detection Office, Department of Homeland Security, before the Investigations and Oversight Committee, House Science and Technology Committee, 17 November 2009.

[175] Matthew L. Wald, "Shortage Slows a Program to Detect Nuclear Bombs," *The New York Times*, pg A-12, http://www.nytimes.com/2009/11/23/us/23helium.html, 23 November 2009 (accessed 7 January 2010).

necessitating a suspension in the continued development and fielding of the RPM portion of the DNDO's detection architecture. In a November 2009 letter to DHS Secretary Janet Napolitano, the chairman of the House Subcommittee on Investigations and Oversight advised the DHS Secretary to scale back the ASP program and focus on improving the PVT monitor technology.[176]

3. Lack of an Over-Arching Strategic Plan or Centralized Authority

The DNDO has driven forward on development of the global detection architecture, but there appears to be no overarching strategic plan developed to shape its efforts. The DNDO identified 74 federal programs that deal with the threat of nuclear and radiological smuggling domestically and overseas. While the DNDO has actively sought to coordinate its activities with other stakeholder agencies, the overarching program requirements and performance objectives governing DOD, DOE, DOS, and DHS efforts that would assist in the integration various programs into a more collaborative and cohesive defense, are largely unarticulated.[177] This high-level lack of strategic planning is problematic for domestic protection, since the implementation and management of various "similar-but-distinct" programs domestically and overseas has great potential for the duplication of effort, waste, and lack of information sharing and interagency cooperation.

4. Remaining Gaps in the Architecture

While great effort has been undertaken to secure much of the global supply chain and ports of entry, other potential pathways still present significant vulnerabilities. The SAFE Port Act of 2006, for example, exempts bulk cargo and approved break bulk cargo from radiation screening. It is unclear whether such

[176] Re Brad Miller, Letter to DHS Secretary Janet Napolitano, Washington, D.C., 20 November 2009.

[177] The DNDO has acknowledged that it has started work on such an integrated strategy, but it is not known to the extent the effort is pursued in other agencies. U.S. Government Accountability Office, GAO-09-257, 2009, 6–9.

cargoes are ultimately screened when they leave the port by rail or truck. Given the nascent status of intermodal rail cargo screening, bulk cargoes may not be getting screened prior to departing the port facility.

Detection and interdiction of radionuclide smuggling along DNDO-recognized pathways as general aviation, land areas between official ports of entry, and small maritime vessels are also in stages of feasibility assessment or early development, but more importantly, are potentially resource prohibitive to secure to a high degree of effectiveness. The inherent limitations of passive detection as demonstrated by the poor detection of shielded nuclear materials, and shortages of key raw materials point to a need for additional technological and operational development.

GAO investigations into NRC licensing highlight that procedural measures are just as critical as technological measures to detect and deny RDD materials to would-be terrorists. Security measures to track sources, such as the NSTS, rely on user-input reporting. Recognizing that successful terrorist attacks like 9/11 utilized key personnel with no criminal background, operating lawfully within existing social institutions, points to the continued potential for regulatory measures to remain vulnerable to deception, and that the investigation and background checks of individuals with access to radioactive material will play an increasingly important role in material security.

J. CONCLUSION

While there is no single solution to the threat of radiological terrorism, it is imperative that the various strategies that make up the DNDO's layered defense-in-depth are conceived, developed, deployed, operated and maintained in such a manner that each program stands a reasonable chance at success, and that together they stand a high probability of success. The current and future domestic detection and denial strategy is by no means perfect. At issue is the ability to keep very small quantities of highly dangerous materials from illegally entering or transiting the country by diverse methods. Reducing the largest

potential threats, such as that posed by smuggling of weapons or material using international container shipping, is prudent. Currently, the global supply chain is much more secure than it was prior to 9/11. However, strategies across potential threat pathways are in various stages of development and implementation, and in some cases are probably several years from security, if at all.

Importantly, the presence of significant gaps and limitations in various pathways and a lack of feasibility data has not stopped the United States from pursuing aggressive security standards such as the 100% screening of U.S.-bound cargo, while defenses against other threat pathways, such as small-craft maritime smuggling, are comparatively nascent. Further, limitations of the passive radiation detection technology itself, as well as in the raw material resources that support it, point to a need for not only developing and implementing alternative and complementary screening technologies for domestic radiation detection, but also for development of an over-arching strategy that places effective assets where they can to make detection and denial strategies as effective as possible. Unilateral efforts on the part of the United States may erode international cooperation on both economic and security fronts, where such cooperation is most needed, without a commensurate improvement in national security.

The Goiânia incident demonstrates the important role that political decisions play in disaster remediation. The magnitude of the impact of an RDD event is only partly determined by such factors as target location, type, amount, and effectiveness of dispersal, and amount of contamination present. Goiânia illustrates that potential contributing factors are the adequacy of response and medical assets to mitigate the immediate and long-term contamination and health hazards, public reaction and public order effects, and political decision making.

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III. PUBLIC EDUCATION OUTREACH

In July 2009, Department of Homeland Security Secretary Janet Napolitano said before the Council on Foreign Relations:

> For too long we've treated the public as a liability to be protected rather than an asset in our nation's collective security … We need a culture of collective responsibility, a culture where every individual understands his or her role.[178]

Is the government developing the public as a national security asset against radiological terrorism? Chapter II showed that the United States is pursuing considerable effort across a range of detection and denial programs to protect the American public. This chapter analyzes the concurrent levels of effort with which the government is developing the "public asset" in regards to security against the RDD threat.

A sound strategy to prevent radiological terrorism from having a maximal effect on society should devote adequate resources to increasing public resilience. This chapter will determine and evaluate public preparedness measures the United States government is pursuing. This chapter will first determine public perceptions of radiological terrorism, to show that public preparedness efforts are needed. Next, this chapter will discuss the programs of responsible agencies that facilitate public education and preparedness efforts and their levels of resourcing, in order to determine if public preparedness resourcing is in line with technological programs towards achieving security.

The research will show that government preparedness and threat education programs for the public are focused on all-hazards, post-event efforts which do not improve RDD threat security, and do not begin to reach the levels of resourcing committed to the no less problematic detection and denial strategies discussed in Chapter II.

[178] Janet Napolitano, "Remarks by Secretary Napolitano at the Council on Foreign Relations," Department of Homeland Security, http://www.dhs.gov/ynews/speeches/sp_1248891649195.shtm (accessed 5 January 2010).

A. PUBLIC FEAR OF RADIATION AND RADIOLOGICAL TERRORISM

Public perception of radiation and radiological terrorism demonstrates that there is a critical need for building public resilience against the RDD threat. The popular fear of radiation is evidenced in risk perception studies and fostered in the public mind by ongoing high-level disagreement over radiation dose safety limits and recurrent radiation incidents and accidents. The threat of radiological terrorism in preparedness studies shows that significant government efforts are required to prevent public fears of radiation from multiplying the effects of an RDD attack.

Public fear of radiation has been demonstrated in scientific studies on risk perception and public opinion polls regarding threat perceptions. Research into popular risk perception in the 1980s has shown, even prior to Chernobyl, that individuals' "cognitive maps" of risks associated with nuclear weapons, nuclear fallout, and nuclear power included perceptions that "these risks are unknown, dreaded, uncontrollable, inequitable, catastrophic, and likely to affect future generations."[179] The disparity between scientific and public perceptions of radiation caused one physicist to conclude that "the public's understanding of radiation dangers has virtually lost all contact with the actual dangers as understood by scientists."[180]

Public fears regarding radiation are further borne out in more recent public opinion polls. In a 1991, Gallup poll of 2,404 American adults on public attitudes towards nuclear radiation, respondents were asked: "When you hear the word "radiation," what are some of the things that come to mind?"[181] The top ten responses by percentage were:

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[179] Paul Slovic, "Perceptions of Risk," *Science*, 26, no. 4799, (April 1987), 285.

[180] Ibid., originally from B. L. Cohen, *Before It's Too Late: A Scientist's Case for Nuclear Energy*, (New York: Plenum, 1983), 31.

[181] *Attitudes Towards Nuclear Radiation*, The Gallup Poll: 22 January 1991 (accessed 2 March 2010), http://institution.gallucom/documents/question.aspx?question=41473&Advanced=0&SearchConType=1&SearchTypeAll=radiation.

Response	Percentage of Respondents (n=2,404)
X-rays	18.69%
Cancer	16.56%
Nuclear Power	14.97%
Death	12.29%
Bombs/Explosions	11.26%
Cancer Treatment	11.03%
Dangerous/Harmful	10.89%
Sickness/Illness (General)	9.17%
Heat	7.03%
Microwaves	6.45%

Table 1. Top ten responses associated with the word “radiation”[182]

Tallying up the percentages of respondents who perceive radiation negatively, while throwing out the response “Bombs/Explosions” as attitude-neutral, shows that nearly 49% of respondents view radiation negatively.

According to the National Council on Radiation Protection and Measurements, public fear of radiation is enhanced by several elements:

- Radiation risks are perceived as new and uncertain.
- Radiation-related technologies are viewed as complicated.
- Radiation accidents are thought to be beyond individual control.
- Radiation-producing technologies like nuclear power plants are considered by many to be both dangerous and nonessential.
- Historical occurrence of radiological accidents and catastrophes.
- Radiation effects elicit strong emotions due to the association with nuclear weapons.

[182] *Attitudes Towards Nuclear Radiation*, The Gallup Poll: 22 January 1991.

- Radiation effects are thought to affect future generations.
- Radiation accidents are perceived to have global consequences, i.e. "fallout."
- Radiation is not detected by human sensory organs.
- Radiation causes diseases like cancer.[183]

A roundtable discussion on the psychosocial impacts of an RDD event conducted by the CDC similarly found negative perceptions of radiation, including that "there is no safe radiation dose," and "safe equals no risk whatsoever."[184] Perhaps more importantly, clinicians and public health workers themselves feel unprepared to respond to radiological terrorism. Charles Miller, the CDC's Chief of the Radiation Studies Branch of the National Center for Environmental Health, stated that some research even indicates a potential unwillingness of medical staff to report to work in a radiological event due to contamination fears, and that "some hospitals have flat out said that their first response in a radiological event would be to call security and lock down the hospital."[185]

Public fear of radiation also stems from conflicting expert opinion of harmful radiation dose thresholds. The Linear No Threshold Hypothesis (LNTH) hypothesizes a linear relationship between radiation dose and adverse health effects, meaning any exposure above zero is potentially harmful.[186] Used as a guiding principle for radiation protection,[187] LNTH opponents, such as the Health

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[183] National Council on Radiation Protection and Measurements, "Commentary no. 10, Advising the Public About Radiation Emergencies: A Document for Public Comment," National Council on Radiation Protection and Measurements, 30 November 1994, 6.

[184] Centers for Disease Control, "Roundtable on the Psychosocial Challenges Posed by a Radiological Terrorism Incident: Participants' Comments, Ideas, and Recommendations, A Summary Report," 6-7 December 2005, 3-4, www.bt.cdc.gov/radiation/pdf/rt-psychosocial.pdf (accessed 22 Feb 2010).

[185] Ibid.

[186] International Commission on Radiation Protection, "Low-dose Extrapolation of Radiation-Related Cancer Risk," 10 December 2004, 9, http://www.icrorg/remissvar/viewcomment.asp?guid={641B1D71-7E2E-4897-A197-F5CD184A9713 (accessed 22 February 2010).

[187] B. John Garrick, Chairman, Advisory Committee on Nuclear Waste, Letter to NRC Chairman Shirley Ann Jackson, 4 June 1999, http://www.nrc.gov/reading-rm/doc-collections/acnw/letters/1999/1090144.html (accessed 19 February 2010).

Physics Society, maintain that actual dose, rather than hypothetical exposure risks, should be used to determine safety standards.[188] LNTH supporters meanwhile argue that there is insufficient scientific evidence regarding the effects of low-radiation dose to warrant departure from LNTH use.[189] In *Permissible Dose*, J. Samuel Walker illustrates how the plight of atomic veterans exposed during weapons tests, the publicity surrounding questionable studies on low-level radiation exposure, and the recurrence of nuclear accidents and incidents have resulted in interagency infighting over regulatory authority, and served to both fuel and fail to solve the debate on safe radiation dose limits in the mind of the public.[190]

Radiation experiments and accidents have also fostered the public fear of radiation. In addition to the open-air nuclear weapons tests of the 1950s and 1960s, the U.S. government engaged in experiments involving the intentional release of radiation. One such experiment, "Green Run," authorized the deliberate release of thousands of curies of radioactive Iodine-131 from the nuclear site in Hanford, Washington, in 1946. The secret experiment was designed to test Air Force radiation monitors, and resulted in numerous claims from downwind communities that the experiment contributed to cancers and other health problems.[191]

The reactor accident at Three Mile Island in 1979 prompted Pennsylvania Governor Richard Thornburgh to issue a limited evacuation of pregnant women and preschool-aged children from the vicinity of the plant. However, the evacuation produced over 200,000 evacuees, who fled an average of 100

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[188] Health Physics Society, "Ionizing Radiation Safety Standards for the General Public," PS005-3, February 2009, Health Physics Society, http://hps.org/hpspublications/positionstatements.html (accessed 22 February 2010).

[189] Garrick, 1999.

[190] J. Samuel Walker, *Permissible Dose*, (Berkeley, CA: Univ. of California Press, 2000), 79, 91–95.

[191] Washington State Department of Health, "The Release of Radioactive Materials from Hanford: 1944-1972" Washington State Department of Health, http://www.doh.wa.gov/hanford/publications/history/release.html#Green (accessed 22 February 2010).

miles.[192] Recalling in Chapter II that the accident in Goiânia resulted in over 110,000 people seeking contamination monitoring, while 248 were found to actually be contaminated, is further evidence of people not only harboring fears of of radiation, but acting on them.

Most famously, the Chernobyl nuclear reactor explosion in 1986 displaced hundreds of thousands of people, spread contamination across Europe, and led to predictions of tens of thousands of cancer deaths.[193] A subsequent study by the United Nations in 2005, however, indicates that Chernobyl's impact was much less than initially predicted. Despite predictions of 4,000 deaths, Chernobyl has caused much fewer, including some 50 deaths of mostly emergency workers, and nine adolescent thyroid cancer deaths.[194] Predicted increases in infertility and birth defect rates did not occur, and the long-term cancer rates among the affected population may increase one percent or less.[195] Importantly, the report found that misperceptions regarding the threat of radiation has caused a "paralyzing fatalism" among affected residents.[196] Some 7 million people in the region receive government benefits and subsidies, but discussions of reducing those benefits due to Chernobyl's less-than-anticipated impacts are politically unpopular.[197]

Not only does the public hold negative perceptions of radiation, but also views radiological terrorism as a credible threat that the government lacks the

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[192] Kai Erikson, "Radiation's Lingering Dread," *The Bulletin of the Atomic Scientists*, 47, no. 2, (March 1991), 35.

[193] Graham Allison, *Nuclear Terrorism: The Ultimate Preventable Catastrophe* (New York: Henry Holt and Company, 2004), 7.

[194] Peter Finn, "Chernobyl's Harm Was Far Less Than Predicted, U.N. Report Says," *The Washington Post,* 6 September: A22 http://www.washingtonpost.com/wp-dyn/content/article/2005/09/05/AR2005090501144.html (accessed 2 Mar 2010).

[195] Ibid.

[196] The United Nations, "Chernobyl: The True Scale of the Accident," The United Nations, 9 June 2005, http://www.un.org/News/Press/docs/2005/dev2539.doc.htm (accessed 2 March 2010).

[197] Ibid.

ability to prevent. A poll of 500 potential voters conducted by the Radiological Threat Awareness Coalition (RTAC) in 2008 yielded the following results:

- 81% of voters believe that the dirty bomb threat to the U.S. is serious
- 70% of voters had not taken steps to prepare for a terrorist attack
- 66% of voters believe that the government cannot prevent a dirty bomb attack
- 56% of voters were not confident they know what to do in the event of a dirty bomb attack
- 64% of voters believed the government was not doing a good job informing people about preparedness for a terrorist attack
- 14% of voters believe the government is the most credible information source on terrorist threats[198]

Similarly, the 2009 Citizens Corps National Survey of 2,400 respondents nationwide found that 33% of respondents felt confident in their abilities to react to a dirty bomb event, while 75% expressed confidence in reacting to a natural disaster.[199] Among the reasons given for not taking steps to prepare for various disasters, 35% of respondents expressed fatalism regarding terrorist attacks, believing that no preparation could help them deal with an act of terrorism.[200] Regarding radiological terrorism, only 19% of respondents said they knew how to respond in the first five minutes after a dirty bomb attack, while 62% felt that they did not know what to do.

Possibly, people's misperceptions of radiation and feelings of dread regarding the potential impacts of radiation has resulted in fatalistic attitudes that are not only difficult to overcome, but are unintentionally confirmed or fostered in the form of government subsidies to affected populations. It is imperative that the

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[198] Pete Brodnitz, *RTAC National Survey #1421, August 2008*, (Washington, D.C.: Benenson Strategy Group, 2008), 8.

[199] Federal Emergency Management Agency, *Personal Preparedness In America: Findings From the Citizen Corps National Survey,* (Washington, D.C.: Federal Emergency Management Agency, 2009), 16.

[200] Ibid., 22.

U.S. government adopt public preparedness strategies that undercut not only the terrorism "payoff" of an RDD attack in terms of popular fear, but also remove doubt from people's minds regarding the impacts of an RDD event by educating and preparing the public in such a way that they are informed and empowered to make decisions and build resilience.

B. U.S. PUBLIC PREPAREDNESS EFFORTS

Homeland Security Presidential Directive/HSPD-8 established an "all-hazards" national preparedness goal for the United states, and defined all-hazards preparedness as preparedness for domestic terrorist attacks, major disasters, and other emergencies.[201] The Citizen and Community Preparedness Act of 2008 sought to amend the Homeland Security Act of 2002 and mandated the creation within FEMA of a Community Preparedness Division (CPD), responsible for all federal, state, local, and tribal efforts towards community preparedness.[202] The Act further established the existing Citizens Corps and Community Emergency Response Team within this division. While the Community Preparedness Act has not yet passed, FEMA nonetheless adopted these structural changes, and now seeks to achieve all-hazards preparedness through engagement and education of all Americans primarily through these programs.[203]

However, a survey of the major public preparedness programs, including Citizens Corps, Community Emergency Response Teams (CERT), the Ready program, and FEMA's Emergency Management Institute shows that these programs are ill-equipped for the task of educating and preparing the public for a

[201] The White House, "December 17, 2003 Homeland Security Presidential Directive/HSPD-8," The White House, http://www.fas.org/irp/offdocs/nspd/hspd-8.html (accessed 8 March 2010).

[202] The Citizen and Community Preparedness Act of 2008, H.R. 5890, 110th Cong, 2nd session, (24 April 2008), Sec. 2101-2103, http://www.govtrack.us/congress/billtext.xpd?bill=h110-5890

[203] House, Statement of Timothy Manning, Deputy Administrator, National Preparedness, Federal Emergency Management Agency, U.S. Department of Homeland Security, Before the Subcommittee on Emergency Communications, Preparedness, and Response, Committee on Homeland Security, 1 October 2009, 3–4. http://hsc.house.gov/SiteDocuments/20091001102820-59262.pdf (accessed 13 March 2010).

radiological terror attack. These programs are hampered by the all-hazards strategy, which lacks comprehensive treatment of the radiological terror threat, and by the utilization of public preparedness programs and tools that are not integrated and otherwise lack the capability to fulfill their public outreach responsibilities.

1. FEMA Citizens Corps

Citizen Corps functions as FEMA's only comprehensive effort to integrate federal, state, local, and tribal governments, nongovernmental groups, and private sector support for citizen and community preparedness.[204] Founded in January 2002 as part of President George W. Bush's USA Freedom Corps initiative to advocate a culture of service, citizenship, and responsibility,[205] the mission of Citizen Corps is:

> To harness the power of every individual through education, training and volunteer service to make communities safer, stronger, and better prepared to respond to the threats of terrorism, crime, public health issues, and disasters of all kinds.[206]

Citizen Corps accomplishes its mission by establishing a nationwide network of state, local, and tribal Citizen Corps Councils. Citizens Corps Council membership may include elected leaders, public and private business representatives, civic and faith-based organization leaders, minority groups, and the media.[207] Citizens Corps Council activities towards public threat education and community preparedness functions include:

- disaster preparedness education;
- public education and outreach;

[204] Federal Emergency Management Agency, "Citizen Corps Overview: Powerpoint Presentation," Citizens Corps, http://www.citizencorps.gov/councils/ (accessed 9 February 2010).

[205] Federal Emergency Management Agency, "Citizen Corps Press Kit," Citizens Corps, http://www.citizencorps.gov/about.shtm (accessed 9 February 2010).

[206] Citizens Corps, "Citizens Corps Councils," Citizens Corps, http://www.citizencorps.gov/councils/ (accessed 9 February 2010).

[207] Citizens Corps, "A Guide for Local Officials," Citizens Corps, http://www.citizencorps.gov/councils/ (accessed 9 February 2010).

- citizen preparedness, prevention and response capabilities training;
- promotion of disaster drills at home, work, and school;
- coordination of citizen participation in community disaster response operations; and
- coordination of volunteer opportunities supporting mitigation, preparedness, response and recovery.[208]

Citizens Corps claims 2,421 councils in operation nationwide, serving nearly 227.5 million people, or 80% of the total U.S. population.[209]

a. Partnered Organizations

Citizens Corps Councils increase community preparedness through evaluating community threats, preparedness needs, and capabilities, and designing and executing local preparedness, education, and outreach activities. Citizens Corps seek also to encourage and create opportunities for volunteer participation primarily through five partnered volunteer programs: Community Emergency Response Teams (CERT), the Fire Corps, USA On Watch, the Medical Reserve Corps, and Volunteers in Police Service.[210]

Fire Corps volunteers enhance the capacity of fire and rescue departments through fire safety outreach, youth programs, and administrative support.[211]

USA On Watch, established in 2002, grew from the Neighborhood Watch program, expanding beyond traditional crime prevention to disaster

[208] Citizens Corps, "Citizens Corps in Action," Citizens Corps, http://www.citizencorps.gov/councils/ (accessed 9 February 2010).

[209] Citizens Corps Web site, http://www.citizencorps.gov/cc/CouncilMapIndex.do?citizencorpsMax= 49&citizencorpsMay=24&citizencorpsMap=Citizen+Corps+Councils#map (accessed 9 February 2010).

[210] Citizens Corps, "Citizens Corps in Action."

[211] Citizens Corps, "Citizens Corps Programs and Partners," Citizens Corps, http://www.citizencorps.gov/programs/ (accessed 9 February 2010).

preparedness and emergency response. It is administered by the National Sheriffs' Association in partnership with the Bureau of Justice Assistance and Department of Justice.[212]

The Medical Reserve Corps program (MRC) coordinates volunteerism among medically trained personnel in communities both before and after a disaster. MRC volunteers support existing local emergency response programs and supplement public health programs including outreach and prevention, immunization, and blood drives. The MRC program is administered by HHS.[213]

Volunteers in Police Service (VIPS) is the law enforcement analogue to the Fire Corps, serving to enhance the capacity of state and local law enforcement agencies through volunteer participation. Funded by DOJ, VIPS is managed and implemented by the International Association of Chiefs of Police.[214]

The ultimate purpose of these programs is to improve first responder capacity in a disaster event. Volunteers perform various support roles that allow local first responders to surge to disaster locations. Presumably, community outreach and education regarding the RDD threat would be provided through a council's determination of need and a corresponding volunteer organization capability to deliver it.

2. Community Emergency Response Teams (CERT)

Created by the Los Angeles City Fire Department (LAFD) in 1985 to train community members in disaster response, FEMA and the National Fire Academy expanded CERT into an all-hazards preparedness program.[215]

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[212] Citizens Corps, "Citizens Corps Programs and Partners."

[213] Ibid.

[214] Ibid.

[215] Citizens Corps, "About CERT," Citizens Corps, http://www.citizencorps.gov/cert/about.shtm (accessed 8 March 2010).

Administered by DHS, CERT is a volunteer program in which members receive training on all-hazard disaster preparedness and basic response skills such as fire safety, light search and rescue, and disaster medical operations.[216] CERT members can then assist others in community preparedness and response.[217] As of March 2010, there are over 3,400 CERT Teams operating nationwide, and it is estimated that over 600,000 people have taken the CERT basic training as of October 2009.[218]

3. FEMA Ready Program

Ready is FEMA's national public service campaign to facilitate and encourage American emergency preparedness, whether natural or man-made. The goal of the campaign is to involve the public and increase basic preparedness for all individuals nationwide.

The Ready program Web site advises citizens to take basic steps towards emergency preparedness: creating three-day emergency supplies kit, establishing a family emergency plan, and becoming informed and involved in community efforts to improve preparedness.[219] The program also includes extension programs, including Ready Business, Ready Kids, and Ready Classroom, and content for specific social strata, such as pet owners and the elderly.[220]

FEMA considers Ready a very successful campaign, reporting 33 million unique visitors to the www.ready.gov Web site, more than 390,000 calls to Ready's toll-free numbers, and more than 39.6 million Ready materials requested

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[216] Citizens Corps, "About CERT."

[217] Citizens Corps, Federal Emergency Management Agency, "Citizens Corps Councils and Partners," http://www.citizencorps.gov/programs/

[218] Citizens Corps, "CERT Map," http://www.citizencorps.gov/cc/CertIndex.do? submitByState (accessed 1 March 2010); on basic training numbers, see House, "Statement of Timothy Manning," 2009, 3.

[219] Department of Homeland Security, "Are You Ready?" Federal Emergency Management Agency, http://www.ready.gov. (accessed 8 March 2010).

[220] Ibid.

or downloaded from the Web as of Sept. 1, 2009. The campaign has also generated nearly $800 million in donated media support.[221]

Central to the Ready program is FEMA's preparedness manual, *Are You Ready? An In-depth Guide to Citizen Preparedness.* The 204-page manual seeks to inform citizens on the importance of preparedness, achieving preparedness, natural and man-made hazards, terrorism, and disaster recovery. Individuals can order the guide in hardcopy from FEMA or download it at no cost from the ready.gov Web site. The manual includes topics on threats, evacuation, public shelters, animals in disaster, and information specific to people with disabilities. FEMA also has released a companion video entitled "Getting Ready For Disaster."[222] Regarding RDD threat information, the 204-page manual includes sections on nuclear blasts, fallout, and RDDs that contain basic information on actions to take before, during, and after an attack, to include evacuation, sheltering in place, avoiding contaminated areas, and basic personal decontamination.

DHS/FEMA also highlight public preparedness through National Preparedness Month (NPM). Created in 2004 as part of the DHS Ready campaign, NPM is a nationwide effort held each September to encourage disaster preparedness at home, work, and school.[223] In 2009, National Preparedness Month saw over 2,700 community organizations promoting a variety of activities to educate individuals, families and communities on the

[221] House, (Statement of Timothy Manning), 2009, 5.

[222] Federal Emergency Management Agency, "Are You Ready? An In-depth Guide to Citizen Preparedness," Federal Emergency Management Agency, http://www.fema.gov/areyouready/ (accessed 9 February 2010).

[223] Department of Homeland Security, "National Organizations Partner to Launch National Preparedness Month," http://www.ready.gov/america/about/pressreleases/release_040810.html (accessed 9 February 2010).

importance of emergency preparedness. Activities highlighted in 2009 included the distribution of emergency preparedness kits, CERT exercises, and preparedness-themed civic events.[224]

4. FEMA Emergency Management Institute (EMI)

EMI serves as the national focal point for the development and provision of emergency management training to improve the capabilities of federal, state, local, and tribal government officials, volunteer organizations, and public and private sectors to minimize disaster impacts.[225] EMI offers resident training to first responders, and online training to first responders and the public through EMI's Individual Study Program. Offering web-based training in over 62 courses, EMI reported that more than 2.8 million individuals participated in the EMI's ISP program In 2007.[226] Courses offered through independent study are free, and some are eligible for continuing education or college credit. Courses with material relevant to improving public awareness and education regarding nuclear and radiological hazards, incident response, and stakeholder organizations (and their estimated completion times) are included in Table 1.

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[224] Department of Homeland Security, "NPM 2009: Event Review," http://www.ready.gov/america/npm09/ October 23, 2009 (accessed 9 February 2010).

[225] Federal Emergency Management Agency, "Emergency Management Institute," Federal Emergency Management Agency, http://training.fema.gov/aboutEMI.asp (accessed 22 February 2010).

[226] Federal Emergency Management Agency, "EMI History," Federal Emergency Management Agency, https://training.fema.gov/EMICourses/ (accessed 22 February 2010).

Course No.	Title	Topics within course with relevance to public preparedness vs. RDDs	Length (hours)
IS-3	Radiological Emergency Management	Radiation Fundamentals, Radiological Hazards	10
IS-5.a	Introduction to Hazardous Materials	Potential terrorist targets, WMD attack signatures, Radiological sources in the community, Individual protection, Community emergency preparedness	10
IS-22	Are You Ready? An In-depth Guide to Citizen Preparedness	FEMA Ready manual certificate course; develop, practice, and maintain emergency plans that reflect what must be done before, during, and after a disaster to protect people and their property, develop an emergency supplies kit	10
IS-301	Radiological Emergency Response	Students demonstrate comprehensive understanding of radiological protection and response principles, guidelines, and regulations	10
IS-302	Modular Emergency Radiological Response Transportation Training	Radiological basics, biological effects, hazard recognition (markings, labels, and placards), initial response actions, on-scene patient handling, radiological terminology and units, assessing package integrity, radiation detection instrumentation, radiological decontamination	6-8

Table 1. FEMA online courses with RDD public preparedness relevance[227]

C. PUBLIC PREPAREDNESS FUNDING

The Homeland Security Grant Program (HSGP) is a FEMA-administered, DHS-funded grant program designed to assist community preparedness efforts at the state, local, and tribal level. The five component programs under the HSGP are a fundamental method for funding and sustaining national preparedness capabilities.[228] Nearly $269 million in HSGP grant money supported all community preparedness programs between 2004–2008, to include almost $96 million for Citizens Corps over that time as shown in Table 2.[229]

[227] Course topic data is not comprehensive of all topics that are taught in a given course. Topics were taken from descriptors in the FEMA EMI Individual Study Program course listing, http://www.training.fema.gov/IS/crslist.asp (accessed 22 February 2010).

[228] Federal Emergency Management Agency, "Fiscal Year (FY) 2009 Homeland Security Grant Program (HSGP) Frequently Asked Questions (FAQs)," Federal Emergency Management Agency, http://www.fema.gov/government/grant/hsgp/index.shtm (accessed 8 March 2010).

[229] U.S. Government Accountability Office, *Emergency Management GAO-10-105T,* (Washington, D.C.: GAO, 2010), 16–17.

Year	Citizen Corps	Urban Area Security Initiative (UASI)[a]	State homeland security	Emergency Management Performance Grant	Law Enforcement Terrorism Prevention Grant	Other homeland security grants[b]	Total
2004	[illegible]	[illegible]	[illegible]	-	[illegible]	-	[illegible]
2005	[illegible]	[illegible]	11,778,317	[illegible]	[illegible]	[illegible]	[illegible]
2006	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2007	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
2008	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Table 2. Homeland Security Grant Programs for Community Preparedness[230]

Community preparedness grants represent a small part of homeland security grant funding, however. While states and urban areas are encouraged to leverage funds from the other HSGP programs to additionally provide for Citizens Corps so that the program can complete its mission, FEMA grant funding for community preparedness programs overall represents less than 2% of the FEMA budget.[231] Comparatively, in 2008, $3 billion in grants funded prevention, protection, response and recovery programs.[232] According to the Congressional Research Service, and, state and local homeland security assistance programs were appropriated $4.2 billion in FY2008 and $4.3 billion in FY2009, as shown in Table 3.

[230] U.S. Government Accountability Office, *Emergency Management GAO-10-105T.*

[231] Federal Emergency Management Agency, “FY 2010 Homeland Security Grant Program (HSGP),” Federal Emergency Management Agency, http://www.fema.gov/government/grant/hsgp/index.shtm (accessed 8 March 2010); U.S. Government Accountability Office, *GAO-10-105T,* 2010, 3.

[232] U.S. Government Accountability Office, GAO-10-105T, 2010, 3.

Program	FY2008 Appropriation	FY2009 Appropriation
State Homeland Security Grant Program	$950	$950[a]
Urban Area Security Initiative	$820	$838[b]
Port Security	$400	$400
Transit Security	$400	$400[c]
Bus Security	$12	$12
Trucking Security	$16	$8
Emergency Operations Centers	$15	$35
Buffer Zone Protection Program	$50	$50
Assistance to Firefighters	$750	$775
Emergency Management Performance Grants	$300	$315
Citizen Corps Program	$15	$15
Metropolitan Medical Response System	$41	$41
Training, technical assistance, exercises, and evaluations	$299	$429[d]
Commercial Equipment Direct Assistance Program	$25	$0
Public Safety Interoperable Communications Grant Program	$50	$50
Real ID Grants	$50	—
Regional Catastrophic Preparedness Grants	[illegible]	[illegible]
Center for Counterterrorism and Cyber Crime	—	$2[e]
Total	[illegible]	[illegible]

a. Of the $950 million for SHSGP, 25% must be used for law enforcement terrorism prevention activities and $60 million for Operation Stone Garden.
b. Of the $838 million for UASI, 25% must be used for law enforcement terrorism prevention activities and $15 million for non-profit organization security.
c. Of the $400 million for transit security, $25 million must be used for Amtrak security.
d. Of the $429 million for training, exercises, and evaluations, $165 million must be used for the National Domestic Preparedness Consortium institutions.
e. The Center for Counterterrorism and Cyber Crime at Norwich University, Northfield, Vermont, is a new grant program in FY2009.

Table 3. FY2008 and FY2009 Appropriations for State and Local Homeland Security Assistance Programs (Amounts in millions)[233]

[233] Shawn Reese, *FY2009 Appropriations for State and Local Homeland Security-RS22805*, Congressional Research Service, 10 October 2008, www.fas.org/sgp/crs/homesec/ RS22805.pdf, 2–3.

D. EFFECTIVENESS OF PREPAREDNESS PROGRAMS

According to the GAO, FEMA community preparedness programs may not be as successful as FEMA officials promote. GAO notes that FEMA's National Preparedness Directorate has yet to develop a strategic plan to integrate Citizens Corps, partnered programs, and the Ready program into the country's National Preparedness System. Additionally, FEMA metrics for success of its programs, to include the numbers of active Citizens Councils, Ready Web site traffic data, and valuations of donated media support, may not be reliable indicators of success because they are not informative of whether or not they actually changed people's behavior.[234] Further, the GAO discovered that FEMA does not have a reliable method of determining the number of active Citizens Corps Councils, and investigators found that only 12 of 17 councils contacted during their investigation were active.[235] Also, the donated media support FEMA receives for the Ready program consisted primarily of advertising space in local telephone directories, and that donated broadcast media included very little prime-time positioning, preventing FEMA from controlling the delivery of its core message.[236]

The effectiveness of community preparedness efforts receives additional criticism from Michael Kindt, whose research into Citizens Corps and partnered program success revealed that the success of these programs is low. In 2006, Citizens Corps claimed 2,117 active councils, meaning that only about 11% of the 19,429 U.S. municipalities were partaking in this program, and claims by Citizens Corps of serving high percentages of the population (73%) likely indicated the disproportionate establishment of councils near population centers.[237]

[234] U.S. Government Accountability Office, GAO-10-105T, 2010, 6.

[235] Ibid., 8–9.

[236] Ibid., 10–11.

[237] Michael T. Kindt, *Building Population Resilience to Terror Attacks: Unlearned Lessons from Military and Civilian Experience*, (Maxwell Air Force Base, Ala.: USAF Counterproliferation Center, Air University, 2006), http://www.au.af.mil/au/awc/awcgate/cpc-pubs/kindt.pdf (accessed 7 March 2010), 22.

To update Kindt's analysis, currently there are 2,430 Citizens Corps Councils, claiming to serve 80% of the population,[238]meaning that only 12.5% of communities are utilizing the Citizens Corps program, an increase of only 1.5% in almost three-and-a-half years. Considering the GAO finding that 12 of 17 Citizens Corps councils they contacted were inactive, it is hard to determine if the program has really grown at all, and in fact may be stagnating. It is difficult to gauge the progress of the Citizens Corps program because Citizens Corps has not released an annual report of its activities since 2004.[239]

In terms of funding, all 50 States, the District of Columbia, and Puerto Rico receive a minimum 0.75% of available grant funding. Additionally, American Samoa, Guam, the Northern Mariana Islands, and the U.S. Virgin Islands each receive a minimum of 0.25% percent of total available grant money, while the balance is distributed based on population share.[240] California's allocation in FY 2009, was $1,153,746, and in FY 2010, was $986,002.[241] California has 37 county-level and 81 city-level councils. Assuming equal distribution among all councils, and that all councils are in fact active, these councils received around $9,800 in federal funds in FY 2009 and almost $8,400 in FY 2010, and may apply funding to:

[238] Citizens Corps, "Citizen Corps Councils Around The Country," Citizens Corps, http://www.citizencorps.gov/cc/CouncilMapIndex.do?nationalCouncilMapForPDFPartner.2.x=46&nationalCouncilMapForPDFPartner.2.y=22&nationalCouncilMapForPDFPartner.2=Neighborhood+Watch#map (accessed 7 March 2010).

[239] 2004 is the latest annual report available. See Citizens Corps, "News and Events: Annual Reports," Citizens Corps, http://www.citizencorps.gov/news/reports/index.shtm (accessed 7 March 2010.)

[240] Department of Homeland Security, "Fiscal Year 2010 Homeland Security Grant Program Guidance and Application Kit," Department of Homeland Security, http://www.fema.gov/government/grant/hsgp/index.shtm#5 (accessed 10 March 2010), 28.

[241] Department of Homeland Security, "Fiscal Year 2009 Homeland Security Grant Program Guidance and Application Kit," Department of Homeland Security, November 2008, http://www.fema.gov/pdf/government/grant/hsgp/fy09_hsgp_guidance.pdf, 24; Department of Homeland Security, "Fiscal Year 2010 Homeland Security Grant Program Guidance and Application Kit," Department of Homeland Security, December 2009, http://www.fema.gov/government/grant/hsgp/index.shtm#5 (accessed 10 March 2010), 29.

- Establish and sustain a Citizen Corps Council
- Develop and implement a plan or amend existing plans to achieve and expand citizen preparedness and participation
- Conduct public education and outreach
- Ensure clear alerts/warnings and emergency communications with the public
- Develop training programs for the public, for both all-hazards preparedness and volunteer responsibilities
- Facilitate citizen participation in exercises
- Implement volunteer programs and activities to support emergency responders.
- Involve citizens in surge capacity roles and responsibilities during an incident in alignment with the Emergency Support Functions and Annexes
- Conduct evaluations of programs and activities[242]

Clearly, states must significantly leverage the other HSGP funding vehicles in order to effectively conduct public education outreach in their communities if Citizens Corps is to fulfill this role.

The most encouraging statistic from FEMA, that over 600,000 people have taken the CERT basic training, does speak well of FEMA's efforts to promote community activism and build capabilities that will improve response operations during a host of disasters. However, it must be said that the CERT training manual views terrorist incidents as beyond the training and capability of CERT members, and that CERT does not appear to focus its resources towards public outreach regarding radiological terrorism. This indicates that for radiological terrorism scenarios, not only are the primary programs silent on educating the public on the threat, but that the readiness progress they have made will be

[242] Federal Emergency Management Agency, "FEMA Preparedness Grants and Authorized Equipment List," Federal Emergency Management agency, https://www.rkb.us/contentdetail.cfm?content_id=227137&GetAELSELCats=1 (accessed 13 March 2010).

negated by limitations in operational capability in a radiological contamination environment. This cannot be considered all-hazards preparedness.

E. SUMMARY OF PUBLIC PREPAREDNESS EFFORTS

DHS and FEMA have undertaken significant efforts since 9/11 to improve public disaster preparedness, and yet significant problems remain in the arena of outreach and preparedness for radiological terrorism. The current all-hazards preparedness approach places all threats into one threat “basket,” resulting in preparedness programs to emphasize disaster preparedness in general terms. For a member of the lay public to become informed about radiological terrorism to the point that it might drive individual behavior towards preparedness, current public preparedness programs are problematic.

FEMA’s main community education and preparedness programs, to include Citizens Corps and its partnered organizations, the Ready program, and FEMA’s EMI are not authoritative, comprehensive, or mutually supportive regarding the radiological threat, and also appear to be underperforming in their ability to improve individual readiness, possibly due to funding shortages.

Citizens Corps and its partnered programs, to include CERT, do not appear to be suitably capable to provide comprehensive public education about specific WMD threats under an all-hazards strategy, given the tailored approach Citizens Corps councils take towards community preparedness, the variability of council composition, and the specific aims and capabilities of partnered organizations. CERT is unlikely to increase first responder capacity in a radiological event due to limitations on CERT training in dealing with terrorism and WMD incidents. Although these organizations may have access to the community resources that can provide increased threat education, they are probably challenged to maximize their efficiency by focusing on the most catastrophic and/or probable disaster scenarios in a given community, such as natural disasters. While prudent, this may ensure that some threat education never happens.

The Ready program also treats radiological threat and response information generally, in lacking centralized, in-depth information on the hazard and response from start to finish, and in not cross-referencing with more comprehensive training resources through FEMA's own EMI Web site, where additional self-study courses for the public are readily available, if perhaps tailored more for members of the response community. The Ready program thus fails to take a leadership role in informing citizens using information that can build public resilience against the radiological terror threat.

It is unclear, then, how the radiological terror threat is effectively communicated to the public through FEMA's primary public engagement programs, Citizens Corps, CERT, or the Ready program. This research indicates, however, that radiation remains both very worrisome to the public, and just as capable of having significant destructive and long-term impacts on a society as more familiar, conventional disasters.

All but the most trained and proactive citizens in an RDD attack scenario will find themselves in a position of immediate dependence on first responders, government officials, and the media, despite the goals of community preparedness programs to reduce dependence and build resilience in disaster scenarios. While the separate community preparedness outreach programs each have their own unique beneficial characteristics, taken as a whole they represent a piecemeal and under-performing approach to public preparedness.

According to the May 2008 Bureau of Labor employment statistics and the National Fire Protection Association, the first responder community consisting of police officers (633,000), firefighters (1.1 million),[243] and emergency medical technicians (207,000),[244] makes up less than 1% of the population. Nonetheless,

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[243] National Fire Protection Association, "The U.S. Fire Service," National Fire Protection Association, http://www.nfpa.org/itemDetail.aspcategoryID=955&itemID=23688&URL=Research/Fire%20statistics/The%20U.S.%20fire%20service (accessed 10 March 2010).

[244] U.S. Bureau of Labor Statistics, "May 2008 National Occupational Employment and Wage Estimates," U.S. Bureau of Labor Statistics, http://www.bls.gov/oes/2008/may/oes_nat.htm#b33-0000 (accessed 10 March 2010).

over the last few years, public education outreach programs like Citizens Corps, which are vital to community preparedness, receive less than half of FEMA community preparedness grant money with which communities must prepare for “all” hazards, and only 0.005% of some $3 billion in homeland security grant appropriations. Citizens Corps, a primary vehicle for determining community readiness strategies and conducting public education outreach, also appears to be stagnating, as only 1.5% of U.S. municipalities have established Citizens Corps councils in the last three years.

Arguably, it is not public resilience to radiological terrorism that is growing, but responder resilience. This is troublesome considering the observed long-term impacts on society from radiological accidents in Brazil, and the former Soviet Union, which include significant psychosocial impacts. Given the demonstrated negative public opinion of radiation, the persistent threat of fraudulent access to radiological materials, and the problematic pursuit of a technological strategy to detect and prevent radiological smuggling, it does not appear that the U.S. can, to a high degree of confidence, prevent a radiological attack from occurring, nor prevent a radiological attack from having a maximum impact on society. Public education outreach and preparedness require much greater efforts.

The next chapter will include analysis and recommendations that can improve technological and public preparedness strategies.

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IV. RECOMMENDATIONS AND CONCLUSIONS

Protecting the nation from the threat of radiological terrorism involves not only deploying effective technological solutions to detect and deny radiological weapons and material smuggling, but also developing the public into an educated and resilient asset that can minimize the effects of an attack. Current government efforts toward RDD threat protection are problematic. Public preparedness programs that are vital to minimizing the impacts of an RDD attack receive miniscule resourcing compared to programs that pursue technological solutions that are of questionable effectiveness and may be years from securing material smuggling pathways. This chapter provides recommendations to improve public preparedness and technological strategies against the radiological terrorism threat.

A. THREAT INTERDICTION STRATEGY

HSPD-8 states that the National Preparedness Goal will establish "measurable readiness targets ... that appropriately balance the potential threat and magnitude of terrorist attacks, major disasters, and other emergencies with the resources required to prevent, respond to, and recover from them."[245] Yet, U.S. detection and public preparedness efforts lack an overarching strategy to guide these programs. In both technological and public preparedness arenas, responsible government agencies are proceeding on congressionally mandated guidelines and organizationally derived priorities.[246]

In the arena of technological detection and denial, a common theme is the lack of adequate strategic planning that creates conflicts with other U.S. interests. Under SFI, for example, the feasibility studies for fulfilling the 9/11 Act's congressional mandate to screen 100% of inbound cargo have yet to be

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[245] The White House, "HSPD-8," 2003.

[246] U.S. Government Accountability Office, GAO-09-257, 2009, 6-9;. U.S. Government Accountability Office, GAO-10-105T, 2010, 13–14.

completed. Nonetheless, the indications from our allies and trading partners are that universal screening is not sustainable. Further, the mandate for 100% screening undermines other incentive-based commercial security programs like C-TPAT, as well as the WCO SAFE Framework, which the United States was instrumental in developing in the first place.

Agency detection and denial programs are beset with other problems as well. DOE's Megaports Initiative is criticized by the GAO as lacking long-term planning guidance.[247] The DNDO RPM program has been accused of using hasty and questionable methodology to develop advanced detectors of debatable cost-effectiveness. The program ultimately outstripped scarce helium-3 resources and ground to a halt.[248] Further, the inherent limitations of passive detection and of the materials needed to create and maintain detection systems point to a need for the United States to pursue active detection and multi-spectral technologies to achieve the high probabilities for detection that are required to prevent illicit material smuggling. Support for research and development of alternative detector technologies that are less vulnerable to resource constraints is also critical to this effort.

In the arena of community preparedness, a lack of integrated strategy has resulted in the use of Citizens Corps and CERT programs of uncertain and limited capability to conduct public education outreach, while the effectiveness of programs, and even the membership of primary organizations, is hard to quantify. Funding for community preparedness programs is dwarfed by other homeland security priorities and the pursuit of technological solutions. The United States needs to develop overarching strategies for material detection, denial, and public preparedness that are effective beyond individual agencies' spans of control

[247] U.S. Government Accountability Office, *Preventing Nuclear Smuggling GAO-05-375*, (Washington D.C.: GAO, 2005), 1.

[248] Global Security Newswire "Homeland Security Backs Off Funding for Nuclear-Detection Technology" (National Journal Group, May 8, 2009), http://www.globalsecuritynewswire.org/gsn/nw_20090508_6590.php (accessed 11 March 2010).

1. Recommendation: Empower the WMD Czar With Strategic Development and Funding Oversight Functions

Currently, the United States is pursuing several suboptimal programs because it lacks unity of effort among agency programs and is indifferent to the international context in which they operate. Empowering the WMD czar with strategic development and funding oversight functions will improve U.S. strategy in a number of ways.

First, it will improve the supervision over, integration among, and cooperation between domestic and international counterproliferation efforts. Nonproliferation strategy will be less heavy-handed and likely to create problems for itself through more consolidated supervision at the national level. Costly, inefficient, and ineffective unilateral programs can be avoided and cooperative regimes and resources can be maximized to a more practical extent.

Funding oversight for technology development can be improved as well. In light of the cost-benefit debate surrounding the pursuit of ASPs, Congress mandated that the Secretary of DHS must first certify a marked improvement in the technology as a pre-condition of spending appropriated funds. The U.S. government should expand on this oversight mechanism, and empower the WMD czar with radiation detection technology certification authority over DHS, DOE, and DOS for border and trade security programs, in order to ensure that technological investment follows complementary global and domestic detection strategies. With the WMD czar empowered as the certification approval authority for technological development, interagency coordination on technology will become more streamlined and cooperative, and the government will be in a better position to ensure that U.S. security programs are cohesive, integrated, and complementary. It is possible that a number of federal programs could be optimized or consolidated, and interagency efforts better integrated even while remaining organizationally and procedurally unique.

Second, empowering the WMD czar with strategic oversight authority will allow the government to develop a consensus view of the radiological terror

threat. A consensus view is necessary to balance the mismatch between technological and public preparedness strategies, and resolve the mixed messages the government sends to its allies, trade partners, and citizens. That message currently is that the threat is on the one hand worthy of unilateral pursuit, even of potentially placing significant drags on our own economy, yet on the other hand does not warrant focused efforts towards public preparedness. With WMD czar strategic supervision, the government could establish a clearer position on the radiological threat, allowing resources to be committed more effectively. U.S. actions would be more even and predictable to our allies and trading partners, possibly increasing opportunities for international cooperation.

It is telling that close U.S. allies like the United Kingdom, which has also experienced significant terrorist attacks, curtailed SFI participation because it conflicted with other responsibilities, like counter-narcotics. Whether this was a smart decision for the U.K. remains to be seen, but the move demonstrates that the British do not view SFI as an effective solution to combating the threat. Arguably, theirs and other nations' willingness to forego cooperation indicates that the U.S. government must take a hard look at U.S. perception of the threat as well as the opportunity costs of detection and denial programs.

With regard to technological detection, the U.S. is proceeding with specific, directed, and costly programs, as if the threat of not only radiological, but nuclear attack, is highly credible and imminent. The government operates in the technological side of radiological threat reduction as if high degrees of self-inflicted pain through unilateral efforts are acceptable. On the public education outreach and preparedness side; however, the government is proceeding as if the radiological threat is one of many threats, and not of such immediacy as to warrant similar specific and directed efforts. This dissonance must be resolved.

2. Promote Research Into Alternative Forms of Threat Isotopes

Cesium chloride is a highly radioactive, soluble, and easily dispersible fine powder. It is used in many large industrial sources, and is vital to the fields of

medicine and scientific research. In short, the outright banning of this substance does not appear to be a practical solution. Research into the development of alternative forms of cesium chloride, to include ceramic and glass formulations, is one possibility for reducing the radiological terrorism threat. According to the NRC in 2008, development of a possible solution may require 4–5 years and $5 million in research and development costs, largely in ramping up to a large-scale process.[249] The NRC has elected to pursue efforts towards securing, rather than replacing cesium chloride for the time being. While changing the physical form of cesium chloride may not work in all applications, cesium chloride represents a large percentage of the total radioactive material of greatest concern. Given what appear to be relatively small development costs, research into radioactive source alternatives for threat isotopes seems a worthwhile endeavor that should be pursued.

B. PUBLIC EDUCATION OUTREACH

Public education outreach is the responsibility of FEMA's Community Preparedness Directorate, which conducts public education outreach primarily through the Citizens Corps and CERT programs. This research shows that these programs are inadequately organized and resourced to provide public education outreach regarding radiological terrorism given their community-based approach towards all-hazards preparedness that emphasizes volunteer participation. Improvements in threat education and outreach are required in order to build greater public resilience.

While these recommendations are geared at improving government agency administered programs, this thesis indicates that the government is not viewed by the public as a credible source for terrorism information. Further research to determine the pervasiveness of such attitudes and the extent to

[249] R.W. Borchardt, "Strategy For the Security and Use of Cesium-137 Chloride Sources, SEC-Y-08-0184," Nuclear Regulatory Commission, 24 November 2008, 5, http://www.nrc.gov/reading-rm/doc-collections/commission/secys/2008/ (accessed 10 March 2010).

which various government agencies are viewed as credible to the public will be useful in developing the role of government agencies in public education outreach. Given the grass-roots approach that promotes civic activism, this thesis assumes that Citizens Corps and CERT (and therefore FEMA) can likely avoid exposure to such popular negative opinion, making recommendations for their improvement appropriate. Arguably, even non-government agencies viewed as credible in the public eye could play a significant and beneficial role in improving public education outreach.

1. Recommendation: Improve Public Education Outreach

a. Improve Existing Education Outreach Programs and Create a Simple, Comprehensive Program

First, FEMA must make public education outreach programs more capable and mutually supportive. First, the various education tools FEMA employs should be better integrated, drawing on the same comprehensive material in order to deliver a consistent message. EMI, the www.ready.gov Web site, and the Are You Ready? Manual need to be more comprehensive and better integrated, providing the public with enough information to make decisions, and directing the public to additional information and training resources as required. Curiously, the *Are You Ready?* Manual does not point the reader to additional training resources offered through EMI.

Second, FEMA should consolidate key topics drawn from the five courses EMI offers on radiation awareness and response (which require nearly 50 hours of individual study to complete) and create one short course tailored for use by the general public. Such a course could serve as the basis for instruction on the radiological threat by public education outreach organizations. This course would also serve as a bridge between EMI's all-hazards-oriented IS-22 Are You Ready? course and the full complement of radiation awareness and response courses EMI offers.

Regarding course content, people need to understand the threat within a social context in order to make safe and informed decisions. This includes not only the threat of terrorism, but also those aspects of response and mitigation that can inform their preparedness decision making. The combined course on radiological terrorism awareness should describe radiation types, effects, and the isotopes that emit them, terrorist aims, the implications of clandestine or overt dispersal, and immediate action drills in the event of various dispersal scenarios. This will educate people on the different radiological scenarios that may occur, and the dangers posed by different isotopes and dispersal events.

More importantly, the course should provide an overview of responder actions as well as near, middle, and long-term decision points regarding mitigation of the hazard. Knowing not only the hazards, but also the decision points and action levels that responders and leaders will face in an attack, is key information that can place a radiological attack into a context that informs citizens to a degree that drives preparedness behaviors, community engagement, or at the very least, steels them into positions of resolve for various threat scenarios. First responders own the monitoring equipment that will be used to determine the extent of contamination. Citizens will likely want to know how that information will get to them; how much radiation will prevent first responders from conducting operations; how much of what type of contamination the public should be concerned about; and the standards and decisions surrounding mitigation of the hazard. Such discussion gets to the heart of community involvement, and will increase readiness-seeking behavior.

b. Improve Education Outreach Program Capabilities

FEMA must improve Citizens Corps and CERT capabilities to conduct education outreach regarding radiological attack, or create additional capabilities elsewhere. First, FEMA can leverage EMI, FEMA, DHS, or other agency expertise to develop an outreach training program for Citizens Corps and

CERT. FEMA could provide the training to county-level Citizens Corps education specialists who then provide radiological threat awareness outreach functions. This training could also be given as a train-the trainer course to provide training down to the community level if desired. Second, FEMA can also leverage the expertise of national professional organizations like the Health Physics Society through promotion of cooperative public education outreach efforts.

Regardless of the path chosen, DHS should increase public preparedness program funding, and FEMA should develop at least some threat education tools for program-wide use, rather than support individual Citizens Corps councils spending grant money duplicative education outreach tool development. FEMA development of some products could save councils time and money. As a condition of receiving public preparedness grant money, FEMA should mandate minimum outreach efforts by programs across the all-hazards spectrum, particularly in high-threat areas, to ensure that community-level as well as national-level preparedness priorities are met.

c. Use Targeted Incentives to Increase Public Education and Preparedness

Improving the tools and capabilities of education outreach programs will improve preparedness to a degree. Unfortunately, large percentages of the population will likely remain unwilling, unable, or uninterested in devoting time to radiological threat awareness or preparedness, and may never visit a Web site or attend a community preparedness meeting. Admittedly, community preparedness for radiological terrorism presents significant barriers to the public. Nuclear radiation is undetectable to the human senses, and involves scientific concepts and terminology that can be difficult to understand. These barriers must be overcome, and one method that may improve readiness is in incentivizing preparedness.

FEMA’s EMI, as noted earlier, offers continuing education and college credit for many of its courses. Other programs exist at the state level that incentivizes preparedness. Many states incentivize preparedness already.

Virginia and Florida offer tax holidays on hurricane readiness supplies. The government should consider additional incentives to promote readiness.

One potential incentive to increase readiness is to offer a tax deduction for completing specific preparedness training courses. Some might argue that this defeats the purpose of instilling a sense of community and individual responsibility towards disaster preparedness. Considering that there has not been a significant terrorist attack since 9/11, much less an act of WMD terrorism, however, the lay public's incentive to devote several hours to completing distance learning coursework on radiological awareness and response is low, despite government warnings of the threat.

Other incentives could involve partnering with businesses to provide tax incentives or even direct funding through homeland security or economic stimulus programs to defray the costs of businesses providing an array of popular incentives such as gift certificates towards purchases of food, entertainment, or merchandise for attending specific education outreach activities completing FEMA or DHS-specified training courses through EMI. Imagine an individual sees a media ad during National Preparedness Month that offers an array of incentives for taking a one-hour online preparedness course. The individual takes the course, and the successful completion is recorded by FEMA through EMI as a definitive metric of public preparedness participation. The individual receives a promotional code (perhaps a number on a course certificate) and is then directed to a Web site where several participating businesses offer an array of incentives from which the individual may select. The individual selects and prints an incentive coupon for use at the participating business. The code is used by the participating business to receive tax or funding incentives from the government.

This research has illustrated the significant psychosocial impacts that could accompany large radiological accidents and that despite spending billions on technology, protection remains problematic. FEMA and elected leaders at all levels, particularly those serving populations in high-value target

areas, should adopt an investment view towards targeted readiness incentives. Tax deductions and other targeted incentives for preparedness training could significantly improve public preparedness, in turn reducing costly public dependency on responders in a disaster.

2. Recommendation: Improve Compulsory Education on WMD Threats

Currently, the Air Force Institute of Technology (AFIT) offers graduate certificate and Master's degree programs in combating WMD, offering both broad and narrow-focused programs in WMD weapon technologies.[250] Improving public threat education and preparedness does not require anything so elaborate. Radiation is already taught in American high school science and physics classes, but may lack the practical context that might improve retention beyond the classroom. If society views WMD terrorism as a credible threat, then greater emphasis on the foundational math, science, history, and social studies concepts of WMD threats are worthy pursuits.

Many may see emphasizing homeland security aspects of public education as a slippery slope towards fear mongering in the classroom. This does not need to be the case. Compulsory education should always seek to challenge students with lessons that will prepare them to succeed in life, in whichever capacity they find themselves. This includes living in an all-hazards world. Focusing more on those topics with security relevance and integrating those topics across subjects can achieve the desired result without broaching concepts like "terrorism" or "homeland security," although these concepts are perfectly appropriate for high school civics courses.

Setting terrorism aside for a moment, if compulsory education emphasized the underlying physics, chemistry, and biology *behind* radiological terrorism, popular misconceptions and fears of radiation would be greatly diminished. With

[250] Air Force Institute of Technology, "Combating Weapons of Mass Destruction Program Overview," Air Force Institute of Technology, http://www.afit.edu/en/enp (accessed 11 March 2010.)

American students currently lagging behind their peers in math and science, innovation in improving hard-science education is needed.[251] While some may argue that bringing homeland security and terrorism into the classroom politicizes education, it must be said that it nonetheless provides students with additional real-world contexts for studying dry and challenging subjects that are often lacking in compulsory education.

C. CONCLUSIONS

How seriously the United States views the threat of radiological attack is not clear from a survey of U.S. government detection, denial, and public preparedness strategies. This thesis shows that there is a significant discrepancy between technological and education outreach efforts. In terms of technological detection and denial strategies, the threat appears to be taken perhaps too seriously. It appears that the nation so fears radiological attack, it is willing to rush the deployment of technologies of apparently limited effectiveness, and risk potentially significant costs through unilateral security programs of unknown feasibility. In terms of public education and preparedness, the threat of radiological attack appears lost amid the spectrum of natural and man-made disasters, without comprehensive and well-resourced programs to increase public awareness and encourage preparedness.

This thesis indicates that the overall U.S. strategic approach is strongly biased towards technology, unilateralism, and de-centralization. To the extent that U.S. programs are effective, current detection and denial programs build local government and responder capabilities rather than an informed and resilient nation. This discrepancy can only be resolved through the development of a cohesive perception of the threat at the national level. Currently, U.S. strategy fails to develop the public as a national security asset, preserving public dependence on government assistance in the event of a radiological attack.

[251] CNN, "Obama Pushes Math, Science Education," CNN, 23 November 2009, http://www.cnn.com/2009/POLITICS/11/23/obama.science/index.html (accessed 11 March 2010).

This thesis indicates that the U.S. government has not done an adequate job of calculating the opportunity costs of its radiological terrorism prevention strategy in a headlong attempt to achieve security unilaterally. The U.S. government risks squandering the resources it ultimately seeks to protect. Unilateral efforts regarding the radiological threat could alienate allies and trading partners, and incur costs that ultimately affect trade. Unilateral efforts also forego cooperative regimes, requiring the commitment of greater resources to achieve security than might otherwise be necessary through cooperative regimes.

The government has also not adequately invested in public preparedness against radiological terrorism. The pursuit of highly effective detector technology is critical to an effective strategy, but it should be pursued in conjunction with public education and preparedness strategies to minimize the potential long-term impacts a radiological attack may have on society. Despite U.S. efforts towards all-hazards preparedness, the public continues to fear radiation, feels under-prepared to respond to a radiological attack, is fatalistic on the value of preparedness, and views government sources of information on terrorism as suspect. Under these conditions, a radiological attack could create the same massive burdens on infrastructure and lasting and costly effects on the population as occurred in Brazil and the former Soviet Union. Public preparedness requires greater federal assistance in the areas of improving education outreach program capabilities and resources. Incentives may be useful for markedly increasing public education and community preparedness against threats such as radiological attack.

The United States does not need to "re-invent the wheel" in developing comprehensive and effective tools to improve education outreach or technological detection programs, however. The United States can make significant gains in public preparedness through relatively small changes in oversight and investments in improving and expanding existing programs. National-level oversight of detection, denial, and public preparedness efforts

could overcome the limitations of agency-derived priorities that have resulted in suboptimal and disconnected efforts to protect the nation from radiological attack.

The United States needs to clearly define the standards of success for its various programs, assess its capabilities in each regard, and adjust its strategic focus and resourcing to proceed toward effective security in an integrated manner. By developing comprehensive education outreach tools and programs to increase threat education, making targeted investments in education reform, and providing incentives for specific readiness measures, the United States can greatly reduce popular misperceptions and fears associated with radiological attack, thus transforming the public into a national security asset more secure from the potentially harmful effects of a radiological attack.

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